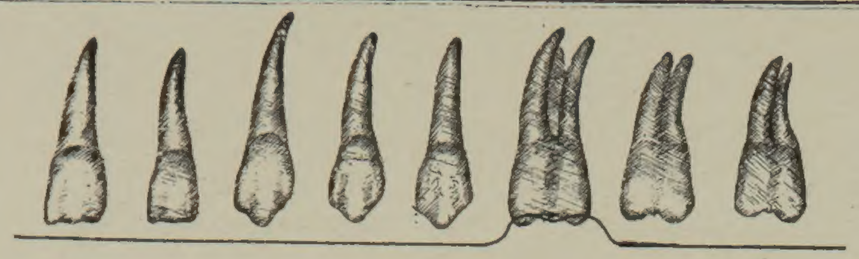
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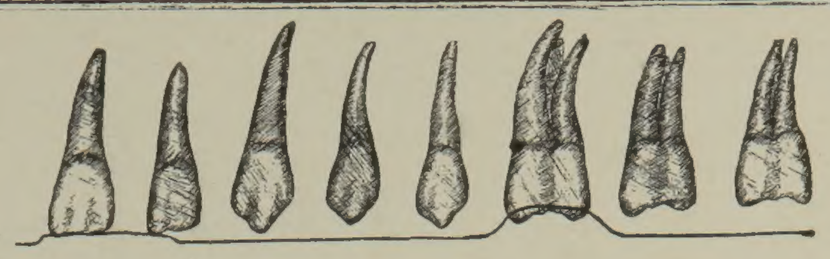
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At Birth.



At one year.



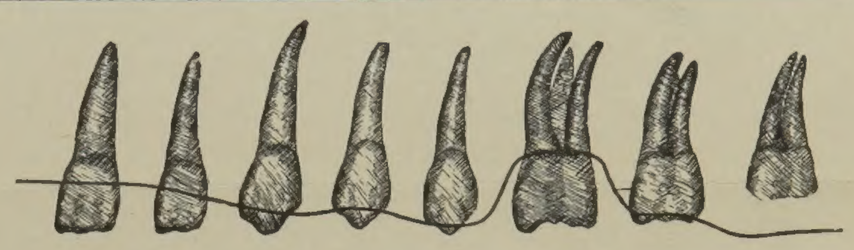
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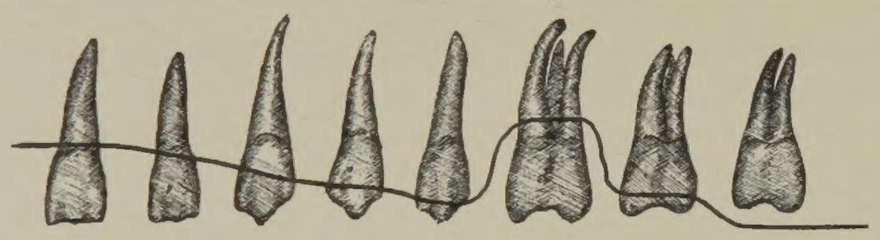
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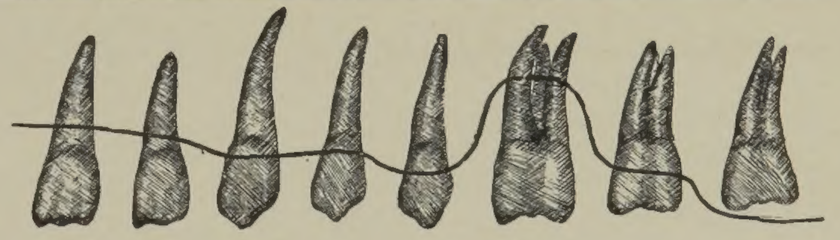
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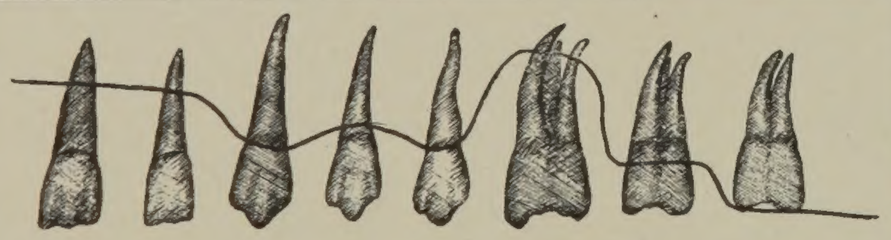
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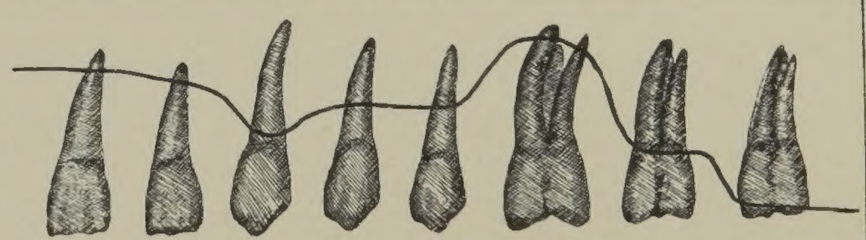
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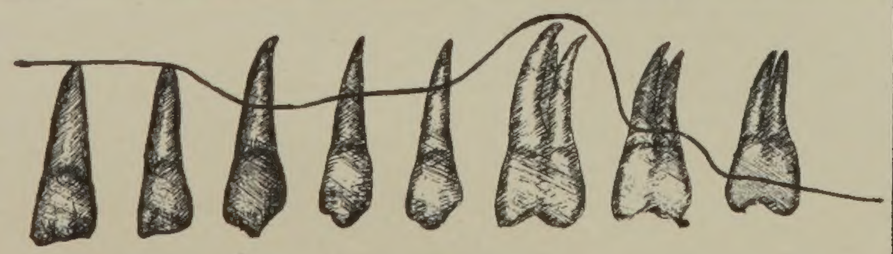
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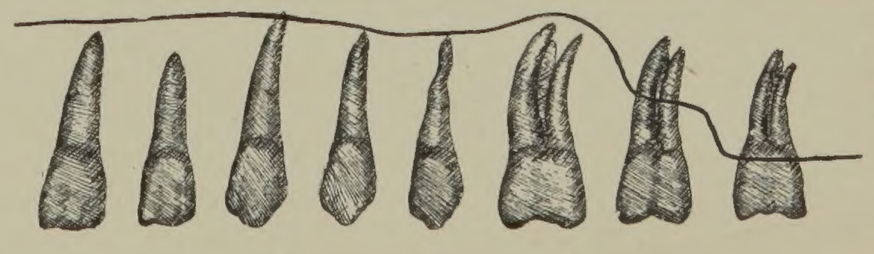
At eight years.



At nine years.



At ten years.



At eleven years.

DR. BLACK'S TABLE SHOWING LINES OF CONTEMPORANEOUS CALCIFICATION OF THE TEETH (PAGE 32).

A

COMPENDIUM OF DENTISTRY

FOR THE USE OF

STUDENTS AND PRACTITIONERS.

BY

JUL. PARREIDT,

Dental Surgeon to the Surgical Polyclinic at the Institute of the University of Leipzig, Etc.

AUTHORIZED TRANSLATION

BY

LOUIS OTTOFY, D. D. S.,

Lecturer on Physiology, Chicago College of Dental Surgery.

WITH NOTES AND ADDITIONS

BY

G. V. BLACK, M. D., D. D. S.,

Professor of Pathology, Chicago College of Dental Surgery.

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AUTHOR'S PREFACE.

DENTAL SCIENCE occupies among the medical specialties a peculiar position, inasmuch as it is practiced by persons educated specially for that branch, and it is for this reason much neglected by the general practitioner. The cause of this condition is not found in a lessened responsibility of the dentist or in a want of efficiency on the part of dentistry. Diseases that occur frequently, such as painful neuralgias, affections of the eyes and ears resulting from dental lesions, the difficult eruption of the wisdom teeth, infiltration of pus into the cavity of the pleura, meningitis caused by the entrance of pus from the maxillary bones into the cavity of the cranium, pyæmia and septicæmia consequent on inflammation of the jaws, may be prevented by timely consultation with a physician well informed in dentistry. This proves the importance and efficiency of the dental specialty, which is a specialty of not less importance than the other specialties of medicine, and upon which the interest of the practicing physician is concentrated.

It is true that under ordinary circumstances the physician cannot perform tedious operations on the teeth so conveniently as the dentist. He has neither the time nor the essential contrivances. The most frequent operation of the dentist—filling teeth—may be especially considered in this connection. The practicing physician should be acquainted with the indications requiring this operation, the essential preliminaries, its subsequent advantages, or its eventual uselessness. In his capacity of family physician he is often placed in a position to give advice or express his opinion in matters pertaining to this specialty, and in such cases it may be exceedingly unpleasant if his opinion is questioned by the specialist, who, after all, is frequently consulted.

The physician should be acquainted not only with the advantages or disadvantages of fillings; he should also be familiar with the requirements, usefulness, or the eventual unfavorable consequences of dental prosthesis. He need not be able to construct the necessary appliances, but he should be in a position to judge whether an appliance in a given case is properly constructed or not.

The most frequent dental operation that the physician is called upon to perform is the extraction of teeth; hence, in this Compendium, that operation is described minutely. During the preparation of this work, the requirements of the physician were continually held in view, they having become perfectly familiar to me during an association of ten years with the medical profession.

JUL. PARREIDT.

LEIPZIG, GERMANY.

TRANSLATOR'S PREFACE.

THIS TRANSLATION HAS BEEN DULY AUTHORIZED BY M. PARREIDT.

WHILE the dental literature of the United States seems in many respects extensive and exhaustive, a work filling a place which this is intended to do, has not hitherto been produced. The excellence of the author as a writer, dentist and scholar, has preferably led to a translation of the work, than to an original production, which might not be as concise, thorough, and in every way applicable, as Parreidt's Compendium.

Originally written in the German language and intended for the German reader, in some respects its adaptability for the American reader was incomplete; hence, the entire volume has been carefully revised, annotated, and perfectly adapted to the wants of the American dentist and physician. The additions made by Prof. G. V. Black,—whose position as an author and scientist adapts him especially for this work,—are added in brackets [ ] to, and are part of, the text.

The notes make the volume useful to the beginner, the student, and the dental practitioner, as well as the physician.

The publisher acknowledges his indebtedness to the S. S. White Dental Manufacturing Co., for the permission to use certain illustrations of forceps.

The metric system adopted in the original work has been retained in the translation, but for the convenience of the American reader, comparative tables have been added at the end of the volume.

LOUIS OTTOFY.

CHICAGO, November, 1888.

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CHAPTER I.

ANATOMICAL AND PHYSIOLOGICAL INTRODUCTION.

Anatomy of the Permanent Dentures.

THE permanent dentures of man consist of thirty-two teeth, divided into four groups—namely: incisors, cuspids, premolars, and molars. The following formula expresses the relative position and number these groups bear to one another:

$$\frac{m_3\ m_2\ m_1\ p_2\ p_1\ c\ i_2\ i_1 \mid i_1\ i_2\ c\ p_1\ p_2\ m_1\ m_2\ m_3}{m_3\ m_2\ m_1\ p_2\ p_1\ c\ i_2\ i_1 \mid i_1\ i_2\ c\ p_1\ p_2\ m_1\ m_2\ m_3}$$

According to custom each tooth is divided into three parts,—crown, neck, and root. The crown projects freely into the cavity of the mouth, the neck is surrounded by the gums, and the root is that portion covered by the alveolar process of the jaws. This, however, is the case only until the thirtieth year is attained. In most persons at that period of life the gums begin to recede, and very soon, in addition to the crown, the neck is also exposed. When the fiftieth or sixtieth year is reached a part of the root is also exposed, in consequence of atrophy of the alveolar process.

Although each tooth belonging to the various groups resembles others of the same group, the resemblance is not very marked and hence each tooth differs more or less from the others

The crown of the incisors resembles the form of a shovel. The anterior surface is convex and the posterior concave. The crown of the cuspid presents on its labial surface a ridge that diminishes in its extent from the margin of the gum to the point of the cusp. From the ridge toward the mesial and distal surfaces, especially toward the premolar the tooth becomes flattened. The incisive edge extends into a point or sharp corner nearly midway in its extent. The cuspids (of the upper jaw, often known as the eye teeth) form the corner of the arch.

The labial surfaces of the premolars resemble in flatness the cuspids. The lingual surface, however, is not so abrupt as that of the cuspid, but more perpendicular; hence the labial and lingual surfaces do not merge into a sharp point, but leave a masticating surface between them. As the lingual surface also ends in a cusp or point like the labial surface, the premolars are often designated as the bicuspids.

The molars are broader and thicker than the premolars, and their buccal surfaces present, instead of a prominence or ridge, two slight convexities. On the masticating surface the buccal side merges into two cusps. Two similar cusps are found on the masticating surface near to the lingual surface. The masticating surface is also traversed by more or less irregular ridges and shallow grooves or furrows. The lower first molar often has five, and the third molar only three cusps. The grinders therefore have three, four or five cusps, and are sometimes termed multicuspids.

The upper incisors differ from one another very much in size. The width of the central on an average measures 8.5 mm, the lateral only 6.2 mm. The first premolar of the upper jaw is generally somewhat wider than the second. In the Caucasian race the general rule seems to prevail, that the first molar should be the largest, and the third the smallest. It is claimed that among inferior races the molars are all of the same size, and among the anthropoids the last molar is the largest.

The lower incisors are narrower than the upper, the lateral is somewhat wider than the central, but still slighly narrower than the lateral incisor of the upper jaw. Of the lower premolars the first is smaller than the second. The molars of the lower jaw, especially the first, are on an average somewhat larger than those of the upper jaw. The latter are inclined to be of rhomboid shape, while the former are cubiform.

In comparison, the teeth of the female are relatively broader than those of the male. The proportion in the male and female according to Quetelet is 16 to 15; the width according to my observations is as 85 to 84.

The anterior twenty teeth, namely, the incisors, cuspids and bicuspids, each have one root except the first upper bicuspid, which has in seventy per cent. two roots; one labial and one lingual. The roots of the upper incisors are round; those of the bicuspids are

laterally flattened. The roots of the lower incisors are the most flattened, while the root of the cuspid combines partly the roundness of the incisor and the flatness of the bicuspid.

Each of the upper molars has three round-shaped roots, two labial and one lingual. The two labial or buccal roots correspond with the greater circumference or the buccal side of the tooth, while the lingual root corresponds with the inner, palatine or smaller circle. The lower molars have two roots, one anterior and one posterior. The roots of the wisdom teeth are subject to the same rules as those of other molars but they are subject to a greater number of exceptions. The diminutive size of the root is especially apparent.

The roots of all the teeth curve slightly backward; that is to say, outward or toward the distal surface they are concave, toward the middle or mesial line they are convex.*

Corresponding to the greater width of the incisors in the upper jaw the arch is larger than the lower, and this is especially true of the anterior portion of it. Hence the upper and lower teeth in articulating do not meet perpendicularly, the lower incisors and cuspids articulate on a slight prominence situated on the lingual surfaces of the upper. The masticating cusps of the lower molars articulate in the grooves and furrows of the upper. There is also a peculiar condition whereby each tooth of the upper jaw when articulating, comes in contact with two of the lower (See Fig. 1, on page 4) teeth.

The upper arch is elliptical in shape; the lower is parabolic. The lower teeth, as a rule, are in close proximity, the incisors frequently lapping. The upper incisors have, as a general rule, a triangular space between one another, and this space exists not only toward the median line but also toward the distal, and the same space also exists between the lateral incisor and the cuspid. Frequently in the upper jaw the incisors overlap each other, in consequence of a disproportion between the size of the jaws and the width of the teeth. This disproportion is the result of the influence

---

*So as not to confuse the terms, "anterior" and "posterior," with "external" and "internal," in this work each tooth will be designated as having a labial or buccal, a lingual, a mesial (facing the median line of the mouth) and a distal surface. That portion of the incisor known as the *anterior* surface corresponds with the *external* surface of the molar, hence the terms labial, lingual, etc., will be more explicit and correct.

of civilization; from a lack of sufficient exercise, in the course of centuries the teeth have lost in firmness but have not diminished in size, while, at the same time, the jaws have considerably decreased in width. The cause of this condition is due to diminished blood-supply to the masticatory organs, the absence of congestion following exercise of the parts, and as the size of the teeth was determined in the embryo, it could not be influenced to the extent as the size of the jaw, which remained in the course of development for twenty-four years.

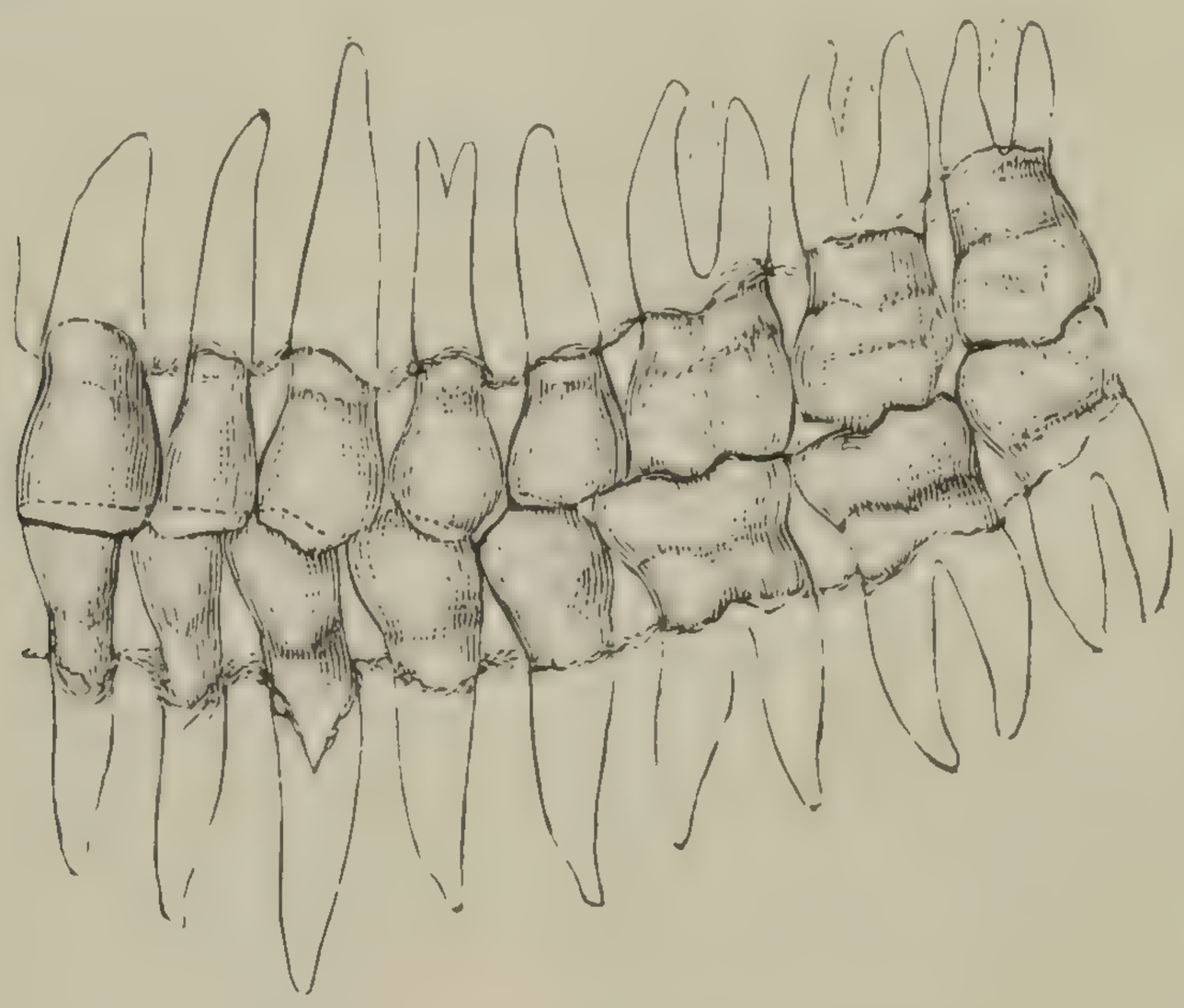


FIG. 1.—*Articulation of the teeth.*

ANATOMY OF THE TEMPORARY DENTURES.

The temporary teeth, as observed in children between the ages of three and six years, are less in number than the permanent, lacking one premolar and two molars on each side, resulting in the following formula:

$$\frac{\underline{m}\ \underline{p}\ c\ \underline{i_2}\ i_1 \mid i_1\ \underline{i_2}\ c\ \underline{p}\ \underline{m}}{m\ p\ c\ i_2\ i_1 \mid i_1\ i_2\ c\ p\ m}$$

The temporary teeth are shorter than the permanent. The proportion of the length to the width is marked. Because of their diminished length the temporary teeth appear short and compressed, though in reality they are smaller than the permanent. The color of the temporary teeth is a milky, or bluish white, while that of the permanent is yellowish. At the time of shedding, the temporary teeth are somewhat worn, a fact that is not to be noticed in the

permanent. Frequently the permanent incisors retain the three cusps, with which they are erupted, upon their incisive edges, but these are subsequently worn off. In determining between permanent and temporary teeth the observer will be aided when it is remembered that the latter are generally somewhat loose.

The roots of the lower incisors of the temporary set are round, and thus differ from the corresponding teeth of the permanent set, the sides of which are flattened. The first temporary molar, according to its form and size, is between the premolar and molar, but most resembles the premolar in form and size. Consequently in its anatomical relation to others it is designated as a premolar. By the English it is generally designated as a molar, while others occasionally take the same view. Notwithstanding the fact that in the upper jaw it has three, and in the lower jaw two roots, and hence resembling a molar more than a premolar, it is designated a member of the last named group. The second temporary molar is a genuine grinder. (See Fig. 2.)



FIG. 2.—*Temporary denture showing crowns of permanent teeth.*

The temporary teeth, as a general rule, do not overlap one another, nor are they so crowded as the permanent. Occasionally, however, especially among the lower incisors, they present a crowded condition resembling slate roofing.

STRUCTURE OF THE TEETH.

A tooth is composed of enamel, cement, dentine, a dental pulp and the peridental membrane.

The tooth-bone or dentine is the principal part of the tooth. It resembles in shape its outline, but is smaller, while it incloses within it the pulp, it is itself enclosed externally, on the crown by the enamel and on the root by the cementum. The density of the dentine has been found to correspond with number 5-6 of Mohs' scale (Apatile-feldspar). The organic substance of dentine amounts to only 28 per cent., the remainder consisting principally of phosphate and carbonate of lime. The cartilagenous basement-substance in

which the lime salts are deposited is traversed by numerous fine canals (0.0013—0.0045 mm. in width), the so-called dentinal canals, that radiate from the pulp and pass in a more or less wavy form to the periphery. Near the pulp they often divide dichotomously, and near the outer periphery of the dentine they form small branches, some of which pass between the enamel prisms, while others unite with the processes of the cement corpuscles. The canals are also united with one another by anastomosing branches. The basement substance immediately surrounding the sheath of the canals is more resistant to the action of acids and alkalies than the intermediate substance. After treating the dentine with hydrochloric acid, Neumann produced a complete plexus of threads that corresponded to the undulations of the canals; these are the so-called sheaths, or tube walls, which cannot be destroyed by boiling in Papin's apparatus.

The dentinal canals contain fibres (Tomes' fibres), which are a prolongation of the layer of cells external to the pulp—the odontoblasts. Blood vessels do not occur in human dentine; nor can nerves be detected, notwithstanding that pain is very intense in lesions affecting the dentine. It is presumed that the dentinal fibrils conduct the pain to the nerve tissues at the periphery of the pulp. It is somewhat doubtful whether this can be the case in so highly organized a being as man. It is probable that with the improvements of microscopic instruments there may follow the discovery of very fine nerve filaments within the dentinal canals, besides the dentinal fibrils.

Near the surface of the enamel and the cementum, but within the dentine there are small globular spaces known as the interglobular spaces. These are caused by imperfect dentine-formation. Dentine is formed in small globular particles, and wherever dentification is not completely homogenous, these interglobular spaces remain. At the union of dentine and enamel, as also at the union of the cementum and enamel, these globular spaces are universally present. They occur, however, in other places as well, and teeth in which they are numerous are of an inferior structure.

Occasionally in making cross-sections of teeth contour lines are noticeable in the dentine. These are caused in some instances simply by concentric layers of dentine, or they may be caused by the globular spaces just mentioned, and finally they may indicate

sudden change in the course of the dentinal canals. Recently Walkhoff called attention to the fact that contour lines may be produced by extensive development of the anastomosing branches of the dentinal canals.

The enamel covers the crown portion of the dentine. At most it may be 2 mm. in thickness, and this is the case on the cusps of the molars; toward the gums it becomes thinner, and entirely ceases at the neck of the tooth, here giving place to the cementum. In hardness the enamel corresponds with No. 7 of Mohs' scale (Quartz). It contains only from 2 to 6 per cent. of organic matter, the remainder consisting of phosphate of lime, carbonate of lime, carbonate of magnesia, fluorcalcium, etc. The inner surface of the enamel can be made visible by removing the dentine with a 50 per cent. solution of boiling sulphuric acid. It shows unevenness and lines in regular order. In its formation enamel consists of six-sided prisms having a diameter of 0.003 mm.; these prisms are occasionally rounded or flattened. They are arranged in bundles, which often cross each other in their course. The enamel prisms contain lime salts; an intermediate substance does not seem to exist. In yellowish teeth, which are hard and hence readily resist decay, the enamel prisms are more regularly arranged than in bluish-gray teeth, which become carious more readily. (See Fig. 3.)

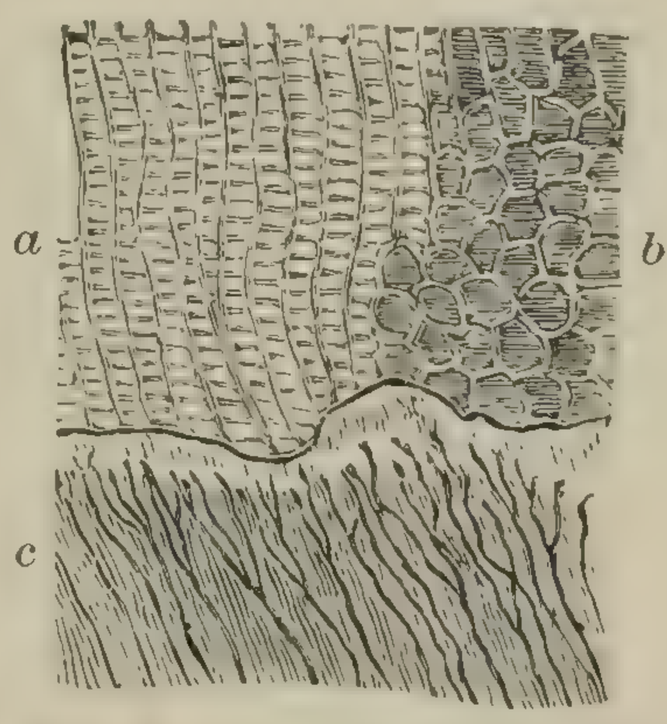


FIG. 3.—*a. Enamel prisms longitudinally cut. b. Enamel prisms transversely cut. c. Dentinal canals.*

The outer surface of the enamel is covered by a membrane known as Nasmyth's membrane or the cuticula dentis, which resists the action of acids and alkalies, and which took its origin from the dental sac resembling connective tissue, while the enamel itself originated from epithelial tissue.

The cementum covers the root portion of the dentine. It commences at the neck of the tooth in very thin layers and continues to increase in thickness toward the apex of the root. On the teeth of young persons, the layer of cementum is thinner, and its external surface especially is less uneven than on the teeth of older people. The cementum is a somewhat dense substance, which is produced from the peridental membrane. In its thicker portions, especially

near the dentine, lacunæ are observable. These are arranged irregularly, and are larger and have more processes than those of bone. The canaliculi from the lacunæ of the cement sometimes connect with the dentinal fibrils. Occasionally larger canals occur in cementum, but the layers of cementum are not sufficiently thick to need Haversian canals. Near the neck of the tooth lacunæ are also absent, and the layer of cementum becomes so thin that only that layer of lime salts remains that is analogous to the globular spaces of dentine near the periphery of the cementum.

The dental pulp, which could also be named the dental marrow, is enclosed by the dentine, and represents the shape of the tooth in a diminished size. It consists of fibrilated connective tissue, without any elastic fibres.

In older persons the structure is tenacious. The outer surface of the pulp is covered by cells resembling cylinder epithelium (see Fig. 4), which contains one or two nuclei and fine-grained protoplasm.

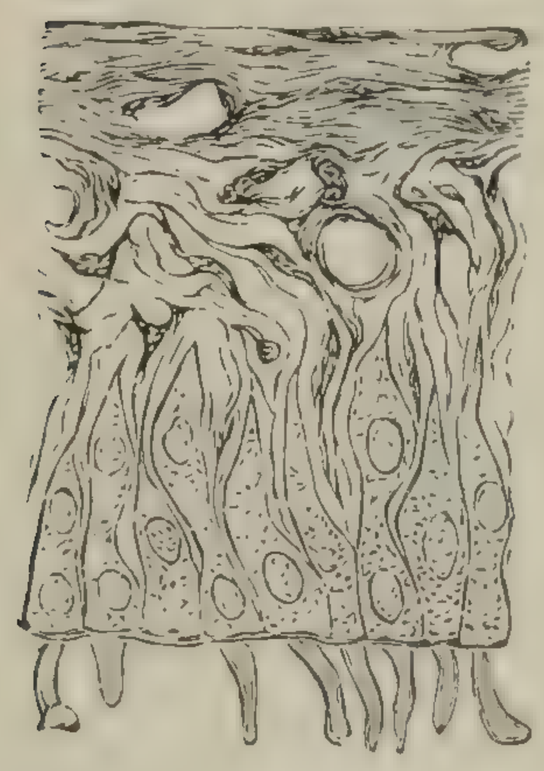


FIG. 4*.—*Showing the external surface of the dental pulp.*

They are connected with one another and the spindle cells that lie just beneath them, by fine processes, and also send processes into the dentinal canals.

The numerous vessels of the pulp enter the tooth through the dental foramen at the apex of the root, traverse the pulp, and at its upper surface form circles. In consequence of the abundance of vessels the pulp almost resembles the structures of a cavernous tissue. There are no lymphatic vessels in the pulp.

The nerves enter with the blood-vessels at the dental foramen, and form numerous branches within the pulp. Boll has seen the double contoured fibres change to naked fibres, and from these latter he saw very fine branches enter between the odontoblasts. The nerve fibres could not be traced into the dentine.

The periosteum or pericementum covers the root of the tooth, and is connected with the bony alveolus, within which the tooth is lodged, as tenaciously as the cementum of the root. It is possible to trace bundles of fibres in the periosteum, that on the one hand are

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*Figs. 1–4 are reproduced from "Wedl's Dental Pathology".

lost in the bone, and on the other hand enter the cementum. These fibres run obliquely upward and downward. On the side nearest the bone the periosteum is a rather dense, richly vascular, fibrous structure. Near the cementum, however, it resembles a fine network. As it perfectly fills the space between the teeth and the alveolus it is uneven in thickness. At the neck of the tooth the periosteum is continuous with the gum and the periosteum of the jaw; at the dental foramen it is connected with the pulp. Wedl discovered in the periosteum vascular tufts from 0.1 to 0.2 mm. in diameter, ovoid in shape, and lying transversely to the axis of the tooth. Larger ones are found about the molars, and especially near the necks of those teeth. They are enclosed by a sac of connective tissue, and Wedl believes it possible that some cases of cyst-formation of the peridental membrane originate from these vascular tufts.

Development of the Teeth.

In the eighth week of fœtal life there appears on the border of the jaw a ridge of epithelium known as the dental ridge (Zahnwall), and from this the epithelial follicles grow into the jaw, and these, later on, form what is known as the enamel organ. Each follicle corresponds to one tooth. From below (in the lower jaw; from above in the upper jaw) a papilla of connective tissue grows toward the follicle, which later on becomes the dentine organ; this is covered by the enamel organ like a cup. About the fourteenth week of fœtal life a vascular tissue is developed about the enamel organ and dentine germ which becomes the dental sac. During the process of ossification there appears in the jaw-bone a groove within which the dentinal follicles rest.

The enamel organ consists of an inner (cylinder) epithelium, an outer (pavement) epithelium and a layer of mucoid tissue between the two. The inner epithelial layer is sometimes called the membrana adamantina. The mucoid tissue originally consists of round cells derived from the rete Malphighii (cylindrical layer). Later, however, the cells become polygonal, and the net-like structure is formed that resembles mucous tissue. The cylindrical cells become infiltrated with lime salts carried to them by the numerous vessels of the dental sac, and thus become enamel prisms. The cylindrical cells thus becoming enamel prisms, are replaced by continual reproduction from the cells of the mucous tissue. The layer of cells

between these two different structures is known as the stratum intermedium. The membrana præformativa is the name given to the formation resembling the cuticle which is produced by the external layer of cylindrical cells, and hence is between the calcified enamel and the membrana adamantina. The cylindrical cells are slightly conical, with their broader surfaces facing externally. The dentification of the enamel commences at the surface of the dentine and proceeds outward. When it is completed, the enamel organ disappears, and the enamel cannot be nourished from the periphery of the tooth, but can be very slightly nourished at the surface lying nearest the dentine. The vessels supplying it become obliterated and the sac itself hardened form the cuticula dentis.

The dentine organ originally consists of fœtal connective tissue. From this there is produced upon the outer surface a layer of cells which very much resemble cylinder epithelium. These are the odontoblasts or dentinal cells whose layer forms the membrana eboris. Below the odontoblasts is a layer of cells designed to replace the previous odontoblastic layer. The dentification of the dentine commences on the inner surface of the enamel and progresses from without inward. This takes place by the deposition of lime salts, which are contained in the blood plasma, into the odontoblasts. The latter form about them a matrix, as they also form the lime salts deposited in the matrix, in a globular form. Between the globules interglobular spaces remain at first, but these gradually become smaller in consequence of the deposition of lime salts, and finally they are almost wholly obliterated; in the course of which tissue formation the odontoblasts become lengthened, and becoming thinner they finally remain in the form of dentinal fibrils within the dentinal canals. Dentification begins during the fifth fœtal month in the temporary incisors, during the seventh month in the remaining temporary teeth, during the eighth month in the first permanent molars, toward the end of embryonic life in the permanent incisors and cuspids, during the second year in the first bicuspids, during the third year in the second bicuspids, during the fourth year in the second molars and during the eighth year in the third molars.

The cementum is developed from the peridental membrane, which remains as the residue of the dental sac.

Upon the crown portion the dental sac is in such tenacious

connection with the enamel organ that it cannot be separated from it, but in the act of rupturing leaves its papilla attached to the enamel organ. Through vessels of the papilla the enamel organ receives its sources for development. The roots of the teeth are not yet present at the time when the enamel organ has disappeared. They are first formed by the appearance of bony tissues between the dental organ in such a manner that for the latter there is only sufficient room left to form the roots. If a tooth is extracted within a year after its eruption it is developed but one-half or two-thirds its normal length. The end of the root is several mm. in diameter, similar to a quill cut diagonally, and when the firmly adherent matrix of the cement is removed (which resembles a cap), from the open end of the root a thick pulp can be removed. The dental walls are as yet very thin. They become thicker in the course of years, during which the odontoblasts are in continual activity, thus the pulp becomes correspondingly smaller. The external surface of the root is as yet smooth. The irregularities that are so readily observed on fully developed teeth are formed during the succeeding cement development. Even the positions of the roots are only determined after the third year of the eruption of the teeth.

The alveoli in which the teeth lodge, are open at birth. The borders gradually encroach towards one another, and in the third month they are nearest. In a child six months of age, the borders of the alveoli become wider, which is proof of the commencement of tooth eruption. The alveoli of the temporary and permanent teeth communicate with one another at this time. About the ninth month these communications become obliterated. Under the temporary teeth, which are lost at a future period, the permanent teeth have large open alveoli.

Dentition.

First dentition normally commences at the age of seven and eight months. First, the lower central incisors are erupted. By the close of the first year the upper central, the lower lateral, and finally the upper lateral incisors will have appeared. In course of the second year the remaining temporary teeth are erupted, beginning with the first molar, followed by the cuspid and completed by the second molar. Frequently, however, they do not appear in this order. Dentition is sometimes delayed a half or one year by various

diseases, especially rachitis. Occasionally, however, in some children teeth begin to appear at the age of five or six months, and then again children are born with teeth. In the latter instances the teeth are generally loose, because they have no roots, and are thus the cause of inconvenience during nursing.

The impetus for the eruption of the tooth is the calcification of the enamel organ, and the closing of the vessels of the dental sac in the crown portion of the tooth, which occurs about the same time. The enamel is not nourished, and hence is almost like a foreign body, and as such irritates the surrounding structures. The latter, therefore, are instigated to increased activity, and as a result rapid cell formation takes place in the Haversian canals, the granulations push the tooth upward toward that part of the jaw covered by the gums. Continuous pressure of the tooth upon the gum causes resorption of the latter, and a tooth appears in the oral cavity. The pressure on the part of granulating structures continues until the tooth extends beyond the gums as far as the enamel reaches. The part of the tooth covered by the cementum remains firm in the jaw. This portion, the root, at this time is developed barely one-half of its length. During the continuation of its development the weaker granulating structure, within which bone formation has already taken place, readily yields space for the root. The latter attains its normal length about two years after the eruption of the tooth.

Second dentition commences with the eruption of the first molar at the seventh year, which is followed by the central incisors in the eighth, lateral incisors in the ninth, first bicuspids in the tenth, cuspids in the eleventh, second bicuspids in the twelfth, second molars in the thirteenth and finally the third molars in the nineteenth year of life. Deviations from this order of appearance and the respective ages as given occur, and it is most frequently in strong children that the teeth appear at a later period. The third molar often appears at the seventeenth year, frequently however after the twentieth, and seldom after the thirtieth; occasionally it does not appear at all. It is a rudimentary tooth.

The temporary teeth must be shed before the permanent teeth, which are developed *behind* (the bicuspids *between*) the roots of the temporary teeth, can erupt in their normal position. This takes place by resorption of the roots. The fully-formed but not nour-

ished enamel of the permanent tooth irritates the surrounding structures, producing granulations that are designed to push the tooth upward. At the same time the pressure of the erupting permanent tooth is the cause of the irritation that leads to the development of the ostecclast cells and the odontoclasts.* These lie in depressions in the surface, being absorbed in the roots of the milk teeth. (Resorption alveoli—lacunæ of Howship.) A number of such microscopic depressions connect, and become macroscopic, and the melting down of the dentine follows.

The pulp ceases to functionate under the impressions made upon it by the resorption process. Its vessels are compressed by the granulating structures, the pulp becomes atrophied, and the less active cell makes way for the stronger. In this manner the resorption structure exerts its influence upon the inner surface of the dentine as well, and resorbs it internally and externally at the same time. In the granulation tissue that fills the space left by the resorbed root there appear bony spiculæ, which are, however, soon replaced by the tooth in process of eruption. Finally, resorption has advanced so far that the temporary tooth has partially lost its connection, and is found to be loose in the act of chewing. This leads to an irritation of the gums, and the slight pain thus caused forces the child to have the tooth removed, if it cannot wait until it is lost in the act of mastication. In a few instances I have observed such perfect resorption of the dentine that only the enamel remained, which showed an extraordinary resistance to the absorbent tissue. (Concerning the difference between temporary and permanent teeth see page 4.)

Occasionally third dentitions are reported. Cases certainly have occurred, but undoubtedly not as frequently as they have been reported. Generally these reports refer to teeth that in reality were part of the second set, but did not erupt, and that only appeared in old age when there was sufficient room for them, or when the jaws had atrophied. While the enamel of these teeth was a foreign body, the same as of those erupted at the proper time, the irritation caused in these instances, in the surrounding structures, was not sufficient to push the tooth without or within a

*According to Wedl and Hohl the multi-nucleated cells, which lie in depressions in the surface of the roots of temporary teeth, are only nests of cells with a covering of connective tissue.

fully closed arch. Such teeth also generally become encapsuled in their irregular positions within bony alveoli. In addition to these normal, retained teeth, occasionally supernumerary or abnormally formed teeth may erupt at a later period.

As an example, Hufeland mentions a case of a man who, at the age of 116, erupted teeth that were shed and again replaced to such an extent that by the age of 120 he had erupted fifty teeth belonging to the third set. Other cases are reported by Hunter, Serres, Harris, and others.

Physiology of the Teeth.

Through the vessels of the pulp, the pulp-cells especially, as well as the odontoblasts, receive rich nourishment. As the dentinal cells extend their processes into the dentine, nourishment can be carried into all parts of the latter. This may be readily observed in jaundiced persons, in whose cases the teeth also become yellow. After recovery the yellow color disappears from the teeth. There is no doubt, therefore, that change of material continually takes place in the dentine. [It is probable that the coloring of the teeth in this condition is due entirely to the coloring matter in the saliva acting upon them from without, especially since it has been observed that teeth that have lost their pulps, and the root canals of which have been filled, suffer the same changes in color as those that have retained their vitality.] On the contrary, the enamel is cut off from all channels of nourishment, although a minimum of exchange may take place at the border of the dentine and enamel, for occasionally the dentine fibrils project between the enamel prisms.

If change of material can take place in the dentine, it cannot be doubted that frequent congestions occasioned by the use of the teeth strengthen and harden the dentine, and that on the other hand in a diminished use of the masticating organs this influence is wanting. The preparation of our food is such that the demand for mastication made upon these organs is very much diminished. Consequently the teeth are defective in structure. Influence upon the enamel can be exerted only before the calcification of the enamel organ in the instance of the permanent teeth, that is, at the beginning of second dentition, during the presence of the temporary teeth. Hence much reliance is placed upon the use of the temporary teeth. If children receive only soft food, that requires no

mastication, the activity which should follow the use of the organs of mastication does not take place; and the tooth, but especially the enamel, upon whose density so much depends, is but partially developed. Sensations of pressure and changes of temperature are but very slight on sound teeth. Pressure is only observable by its continuation upon the root membrane. Exceedingly high and low degrees of temperature are felt in the teeth as in the skin, not as heat and cold, but as pain. A piece of iron heated to 80° C and a piece of ice at 0° C in contact with the teeth are equal in producing pain. But temperatures of +5° to 15° C of cold, 35° to 70° C of warmth, are distinctly differentiated. The sensation of temperature or pain is not immediately observed; the cold or heat must first pass through the enamel in order to be felt. If the enamel is destroyed and the dentine exposed the tooth readily distinguishes even slight differences of temperature. Water at from 15° to 20° C is pronounced cold, and when from 30° to 35° C is pronounced hot; while any temperature below 15° C and above 35° C causes pain. Exposed dentine is also very sensitive to chemical influences. A gnawing sensation follows contact with sour or sweet substances. In a slight degree such a sensation causes "setting on edge." This feeling often follows after partaking of sour food. It is produced by the influence of acids on those positions where the dentine is exposed from wear or fracture, and also from affecting such portions of the tooth where the enamel ceases, and the dentine is covered by a thin layer of cementum. When the gums have receded from the necks of the teeth, as is always the case in later years, the feeling of "setting on edge" is more readily observed than in the young at a time when the gum extends over the border of the enamel.

In function the teeth are organs of digestion and of speech. As organs of digestion their use lies in the grinding of the food. Since among civilized people food is prepared in such a manner that not much remains for the teeth to triturate, it is possible to exist with a smaller number of teeth, and indeed to live decades without teeth. In the wilderness this would be impossible. As a consequence, the teeth are not as well nourished, and hence are more poorly developed from generation to generation, and therefore are more liable to decay.

As organs of speech among civilized people the teeth are almost of more importance than as organs of digestion. The linguals (d, t,

th, l, n, s, which are also named dentals) are produced by a peculiar position of the tongue against the incisors and a current of air that at the same time leaves the pharynx. F, v, ph, pf are produced by the lips and the incisors operating in conjunction. When the anterior teeth are lost, speech is materially disturbed. If but a single incisor is missing difficulties in expression are apparent. It causes a kind of whistling sound which is unpleasant to the ear. In course of time the speech is corrected again, because the tongue becomes accustomed to avoid the space when it is compelled to touch against the incisors. Even though all the upper incisors are absent, the lower ones may make the expression clear. Persons discover how unfortunate they are, in this respect, when the lower incisors have also disappeared. In addition to the difficulty of expression caused by the loss of the anterior teeth, there is another very unpleasant result, namely, the involuntary ejection of saliva from the mouth when talking, and especially when in animated conversation. The absence of incisors in children is also detrimental, because they cannot learn to speak correctly, and hence psychical development is unfavorably influenced.

CHAPTER II.

ANOMALIES OF TOOTH FORMATION.

Anomalies of Size.

Teeth are seldom larger than the normal size. The upper central incisors are on an average 8.5 mm. in width, and they range from 7 mm. to 10 mm. without appearing extraordinarily large or small. But when they are more than 10 mm. in width the deformity is apparent. Occasionally such a wide tooth is caused by a union of the enamel with a lateral incisor. The lateral incisors are frequently abnormally small, and this is also true of the third molars.

Treatment is not indicated for the correction of abnormally large or small teeth.

Anomalies of Number.

Supernumerary teeth are especially frequent in the median line of the upper jaw between the central incisors. Another place frequently occupied by these teeth is the space between the upper central and lateral incisors, and when sufficient room is wanting for them they may stand within or without the arch. Occasionally the normal teeth are forced into the irregular position by the supernumerary teeth, and when they are in the vicinity of incisors they resemble them somewhat in shape. Generally, however, they are stunted, and frequently very small, and are called peg-teeth or emboli.

Near the labial surface of the bicuspids there occasionally appears a third bicuspid, more or less normally developed. Frequently in this locality, as in the neighborhood of the incisors, diminutive tooth-formations of the size of rice-corn occur, though generally they do not erupt. It is very seldom that a supernumerary molar is found.

In the lower jaw supernumerary teeth are less frequent than in

the upper, and less frequent among the temporary teeth than among the permanent, although I have seen supernumerary incisors in the lower jaw of children at the age of four years.

If the supernumerary teeth are located on the labial surface of the dental arch they occasion a deformity of the features; and if situated on the lingual surface of the arch they generally cause annoyance in speech. In both cases, as well as when they are regularly in the arch, their presence is detrimental, being often the cause of caries by reason of their close juxtaposition, forming angles and positions that cannot be kept perfectly clean.

Therefore it is to be recommended in nearly all cases that supernumerary teeth be extracted. This is generally readily accomplished, though instances occur when the supernumerary tooth is so near the normal teeth as not to be readily grasped with the forceps, when difficulties may arise. If once grasped, extraction is generally easy. Dentures, from which normal teeth are missing, are more frequent than those containing supernumerary teeth. The third molar is absent most frequently, next the lateral incisor of the upper jaw, then one bicuspid of the upper jaw and occasionally the cuspid. In all cases it must first be ascertained whether the missing tooth had not been extracted previously. Previous extraction may be determined with almost certainty not to have occurred, if the teeth adjoining the space from which one or more members are missing do not lean toward the space, and if the space is symmetrical. Relative to the third molar, it should be remembered that frequently the first molar is extracted before the twelfth year, and that in those cases the second molar will take the place of the first, and the third that of the second. The third molar standing in the position of the second, if small and round, may be recognized as the third molar.

Occasionally the space from which a permanent tooth is missing may be occupied by a temporary tooth. Sometimes temporary teeth may be seen in the mouth of persons twenty and thirty years of age. The permanent ones are generally retained in the jaws in these cases, and may erupt later. The temporary tooth, however, should not be extracted, since the permanent one may show no disposition to erupt. It must also be remembered that it may have been extracted at a previous time while in its effort to erupt it placed itself in an irregular position. The retention of the permanent teeth

within the jaw is often hereditary.* Of the temporary teeth, seldom any fail to erupt.

Single missing teeth are not generally a hindrance. The appearance is not much detracted from, since the spaces are generally small and symmetrical. In some cases when the cuspids are too near to the median line because of missing lateral incisors, and are therefore unsightly, the cusp may be ground off. If the spaces between the central incisors and the cuspids are so large as to cause disfigurement, artificial lateral incisors may be inserted.

Peculiarly deficient in development are the dentures of hypertrichosic persons, but this deficiency may exist only in some of them, since others may have normal dentures, while others again may have hypertrophy of the alveolar process or of the gums. I had an opportunity to examine one of the best known hypertrichosic persons, Fedor Jeftichejew, who, in 1883, was thirteen years of age. He had in the upper jaw only two and in the lower only three rudimentary teeth. His hair was as soft as silk, resembling down. Other epidermal tissues, such as the nails, sweat glands, etc., were only weakly developed. In other cases of hypertrichosis, which are recorded as certainties in literature, soft silken hair coincides with poorly developed teeth and other epidermal tissues. On the other hand, normal dentures or hypertrophy of the gums with other powerfully developed epidermal tissues may be found in hypertrichosic persons who have strong black hair.

Anomalies of Position.

There are prominent deviations from the normal articulation of the teeth as shown in Fig. 1 on page 4.

A. While normally the upper dental arch is elliptical in form and the lower parabolic, and the lower incisors are forced to articu-

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*I know three persons of one family in whose cases this is particularly observable. In the mouth of one brother the temporary cuspids were in their positions in the twenty-eighth year. In the next year they were extracted in consequence of caries extending into the root, but the permanent never erupted. In the case of another brother, the lateral incisors of the upper jaw were missing. In one sister, the lateral incisors of the upper jaw, one bicuspid on each side as well as the second and third molars of the upper jaw were absent. The mother of these persons is said to have died several years ago; in her fifty-first year she is said to have erupted teeth. It was most probably at this time that some of the missing teeth of the second set were erupted.

late with a projection on the lingual surfaces of the upper, in the *overhung articulation* (as it may be termed) the lower incisors have a separate line from one cuspid to the other, and are at the same time so high up and lingually irregular that their incisive edges, instead of touching the lingual surface of the upper teeth, are immediately behind them and touch the gums. The bicuspids in such dentures appear much shorter than the incisors and cuspids.

In case artificial teeth are required in these instances much difficulty is experienced, since the thinnest gold plate upon which artificial incisors for the upper jaw may be fastened is struck by the lower teeth and thus causes a space to remain between the masticating surfaces of the molars during occlusion. The vulcanite now

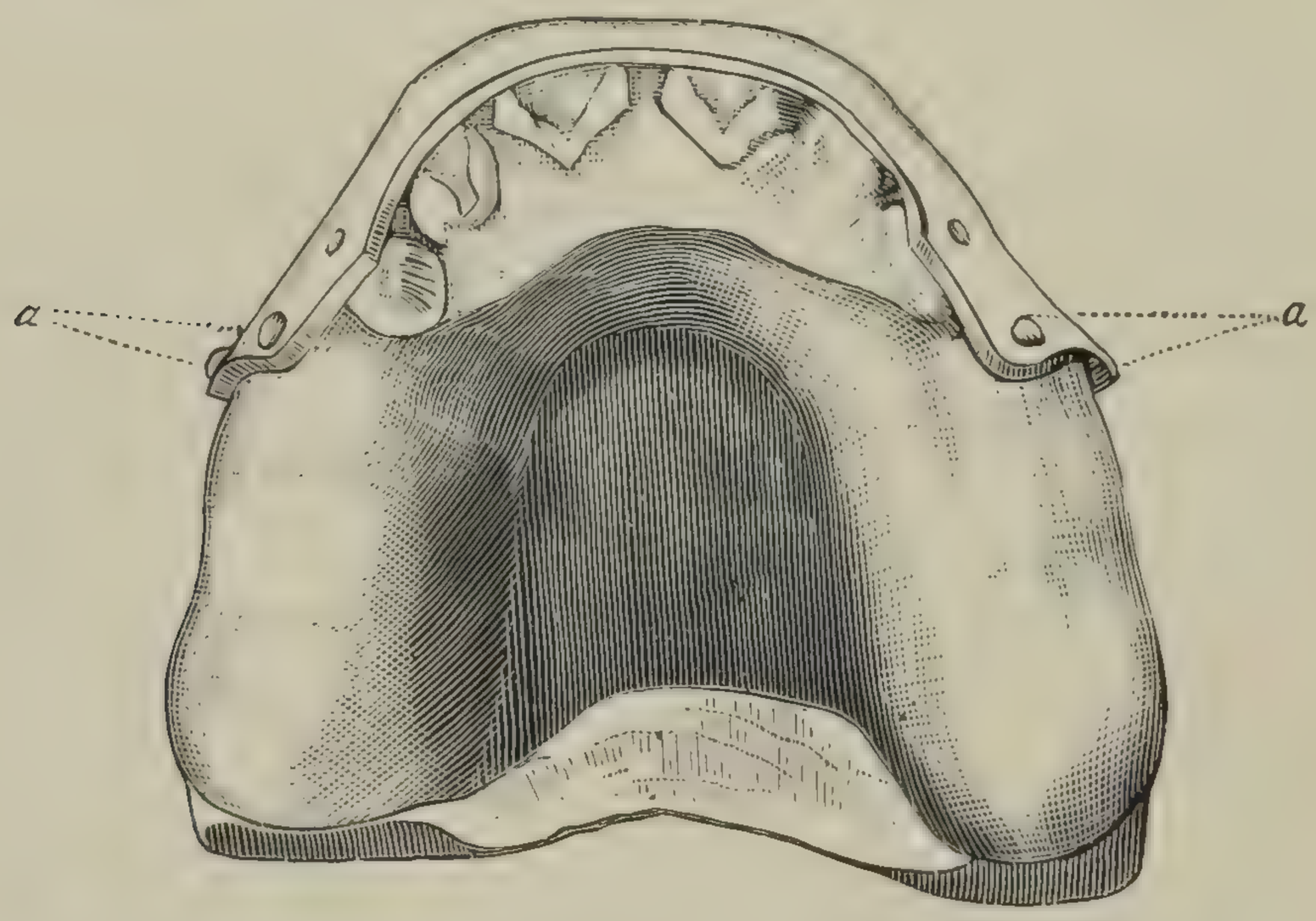


FIG. 5.—*Kühns' apparatus for pushing back protruding teeth.*

so much employed as a base for artificial substitutes cannot be used in these cases, and in using gold plates the lower incisors must be ground on their incisive edges until the molars can articulate properly.

In other respects the overhung articulation is no deformity and needs no other treatment.

B. In the os æthiopum, *negro mouth*, the incisors and cuspids, instead of standing perpendicularly, incline slightly forward. In these cases the incisors seem long, and in course of time they become even longer because the upper and lower do not meet perpendicularly.

As a rule there are no spaces between any two of the teeth. The appearance is displeasing, and correction is frequently desired. This can be accomplished by making a rubber plate,* which entirely covers the molars and into the sides of which metal hooks or buttons are vulcanized, to which elastic rubber, about 1.5 cm. in width, may be fastened, and when this rubber band is drawn tightly over the anterior teeth they are gradually brought back into their proper position. From time to time the rubber is renewed by shorter pieces until finally the teeth are in their proper positions. First the lower and afterwards the upper teeth should be treated in this way. The plate should be worn at least three months after the teeth have taken their new positions, as otherwise they may recede into their former location. In some cases the tendency of the teeth to grow forward is so marked that they again fall into their former positions as soon as the retention-plate is removed. In the prognosis this possibility should be thought of.

C. If the upper and lower incisors have a tendency to incline backward instead of forward, the so-called *senile-mouth* deformity results, which causes the upper and lower incisors to resemble a groove whose concavity faces forwards.

This deformity occurs but rarely, and needs no treatment.

D. The *square articulation* differs from the normal in that the lower incisors, instead of articulating on the lingual surfaces of the upper, meet them on their incisive edges. As a result the teeth are markedly worn off in the course of time; otherwise the square articulation is no deformity.

E. The *cross-bill articulation* is that in which on one side the lower teeth articulate normally behind the upper, but on the other side in front of them. One tooth (at the point of crossing) articulates almost perpendicularly with the incisive edge of its antagonist; hence these teeth are worn off more rapidly than the others. The deformity is generally not very marked, and usually requires no treatment.

[There are a considerable number of cases of irregularity of this variety met with in practice, that markedly distort the features, and which may be readily corrected by a properly adjusted apparatus. These especially should be corrected early before the teeth

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*Kühns, in *Monatschr. für. Zahnh.* 1885, January number.

are much worn at the point of crossing, as this causes another deformity (the misshaping of the teeth) that is difficult of correction. Furthermore, the cross-bill is often caused in part or entirely by some particular tooth interfering with the normal closure of the teeth, and thus forcing the jaws to assume another position, to which they slowly become habituated. If the difficulty is found and corrected early, the closure readily resumes its normal position, and deformity is prevented.]

F. The *open articulation*, of comparatively rare occurrence, is characterized by the fact that in closing the jaws on each side only the last lower molar articulates with the last upper molar, thus causing a space between the upper and lower teeth, which is largest at the median line of the mouth. The cause of this deformity, according to Wedl, is a short ramus of the jaw, by which the lower dental arch receives a forward inclination.

The deformity is not corrected by the extraction of the last tooth, for in that case, as before, only the next tooth will be in contact with its antagonist, while the others cannot articulate. Elastic bandages have been recommended, by the use of which the anterior portion of the lower jaw is pressed against the upper teeth, and thus the tendency of the growth of the jaw is altered; but this treatment is not always followed by the desired results.

G. In the *protruding upper jaw* when in contact with the lower molars there is a space between the upper and the lower incisors, which measured from before backwards may be from 1 to 10 mm. The upper teeth in these cases appear very prominent. The deformity cannot be entirely remedied by pressing the teeth inwards, as the alveolar process of the upper jaw forms too large a circle. At best, the upper teeth may be given a somewhat backward inclination, and the lower may be pushed forward.

H. In the *protruding lower jaw*, when in occlusion, the molars articulate normally, but the upper incisors fall behind the lower.

If the latter do not project too far forward the articulation may be readily corrected by applying pressure on the labial surface of the inferior, and on the lingual surface of the superior incisors; in the lower jaw, however, space should be secured for the teeth to be pushed back by the extraction of a bicuspid, or possibly of a carious first molar. It is also necessary to encase the masticating surfaces of the molars in the regulating apparatus in order that the

upper teeth, in being pushed forward, may not be hindered by the occlusion.

I. The V-shaped jaw. The alveolar process of the upper jaw is normally elliptical in form. Occasionally, however, it does not receive the proper convexity in the neighborhood of the cuspids and bicuspids; and thus the arch forms a straight line from the central incisor to the first molar, causing an angle between the central incisors. Such a condition is known as the V-shaped jaw. This deformity is the result also when the bicuspids of the two sides approach each other, forming an angle whose concavity faces outward, and whose vertex is formed by the bicuspids of both sides. In some cases, instead of a decided angle there is only a circular depression of the gums.

These deformities are corrected by a plate designed to enlarge the arch, a familiar one known as the Coffin-plate. (See Fig. 6.)

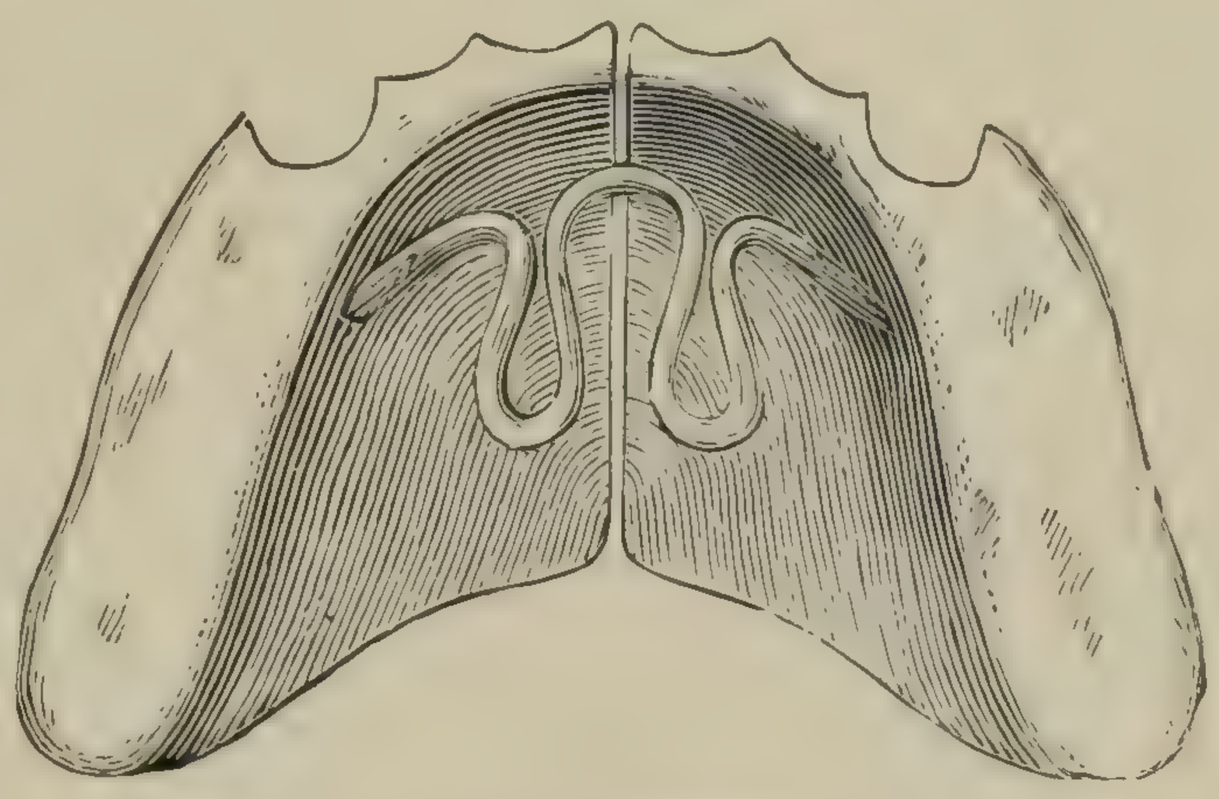


FIG. 6.—*Coffin's Expansion Plate.*

It is made of vulcanite exactly fitting the gums, and covering the crowns of the molars and bicuspids, fitting around the necks of the incisors and cuspids. The plate is cut across at the median line, corresponding with the suture of the superior maxillary bone, thus forming two halves. The two halves are held together by a W-shaped spring made of piano wire, whose ends are vulcanized, and fastened into the halves of the rubber plate. It is worn constantly, and the spring exerts a continual pressure, thus pushing the two halves of the plate from each other, which results in an expansion of the arch. The arch may also be widened by screws or pieces of wood, if they are so attached to a rubber plate as to exert pressure upon the lingual surfaces of the teeth to be moved.

Solitary irregular teeth occupy the largest variety of positions inside or outside of the arch. They may be anteverted, retroverted or rotated; occasionally they are located quite a distance from the normal position.

The most frequent cause of irregularity of the teeth is the unnatural proportion between the size of the jaws and that of the teeth. This disproportion has arisen principally from the continual neglect of sufficiently exercising the teeth in mastication for generations past. It is well known that an organ that is in constant use becomes much more fully developed by reason of the continually recurrent supplies of nourishment, than is one not so much used. The teeth are subject to the same law, and as their use is limited (the kitchen performing their work), they have suffered from defective development. These influences, resulting in inferior development, cannot be made apparent on the size of the teeth, for the size is determined at the commencement of dentification, and in the case of most teeth, during fœtal life. The influences interfering with development can operate only upon the structure. Nevertheless, the same influence exerts itself on other parts of the organs of mastication, especially upon the jaws, by reducing their size. The jaws become smaller because the influences retarding their development are in operation during twenty-four years of each generation, and hence, in the course of centuries, the results are correspondingly more rapid than the same influence upon the teeth can be, as its operation on the latter is limited to but a few months or years in each generation.

[With the more general practice of correcting irregularities of the teeth that has obtained within the last few years, there has been much modification in our ideas as to the necessary apparatus. And as usual in other lines of progress, the operations have become much simplified. The classes of cases amenable to treatment are also extended with increasing knowledge, and now it may be said that almost any deformity that has its basis simply in irregular positions of the teeth may be readily corrected. Very generally those teeth that have taken a wrong position simply from having been thrown to this side or that from some hindrance at the time of eruption, and have not space on account of consequent contraction of the arch, can be brought into position within a few weeks by a well arranged spring attached to proper teeth by one or two bands, or by a wire attached by such bands and passing about the arch to serve as a fixing point for rubber bands. Usually a plate may be dispensed with. In case a tooth seems not to have room to come into place, the tooth itself may, under continuous pressure, act as a wedge, and the change in the arch for its accommodation will occur so gradually,

and still not be too tedious, that the change in the arch can scarcely be observed. Even in cases in which one, two, or more of the upper incisors close behind the lower teeth, I seldom find it necessary to use any more extended apparatus, or use anything to hold the upper and lower teeth asunder. As the teeth are drawn toward their proper position a time comes when they will "jump the bite" and pass on to their position without especial inconvenience to the patient.

In cases of greater deformity, in which there is marked deformity of the alveolar ridge, as in case of a marked V-shaped arch, a plate is still necessary, but this has been made to work so accurately and with such certainty that it is not regarded as difficult to bring such cases into normal form. The apparatus necessary in such cases can not be described here for want of space. It must be thought out and constructed by the specialist, and its adaptability to the case in hand must depend upon his inventive genius and skill of construction.]

In the treatment of irregularities it should always be observed whether the teeth standing outside of the arch can find space within it. If this is not possible, space should first be obtained. This can be secured either by an artificial enlargement of the arch (by constant pressure upon the lingual surfaces of the teeth), or by reducing the number of teeth, extracting a bicuspid or a decayed molar. The pressure whereby the teeth in question may be moved is secured by spiral springs, screws, expansive pieces of wood and elastic rubber. A rubber or a metal plate is always necessary, and to this the special parts of the apparatus may be attached. The plate, as a general rule, must cover the gums and the molar teeth.

The orthodontic treatment refers generally only to the incisors. The molars are of less consideration, because their malposition does not cause a visible deformity, and then too, the molar teeth are not so frequently irregular. The third molar of the upper jaw often presents its masticating surface toward the cheek or even backward, and in these cases, generally, should be extracted. Bicuspids are occasionally out of line toward the lingual surface; these are usually extracted unless in the immediate vicinity there is a carious tooth that it would be best to extract in order that the irregular but healthy tooth may take its proper position within the arch.

[Serious difficulty occurs occasionally from retention of one or

more of the permanent teeth. It happens occasionally that a tooth develops in a position that is so far wrong, that it cannot present in its proper place, nor even upon the alveolar ridge at all, but remains buried in the bone or beneath the tissues covering them. In this case the crown of the tooth, which, when fully formed, loses vital connection with the tissues upon its external surface, becomes encysted. It may remain in this condition during the life of the individual, and not become the cause of serious difficulty. But in a minority of cases there occurs an enlargement of the cyst about the crown from distention by cystic fluid or from the occurrence of inflammation and suppuration. In the event of either of these conditions resulting the case demands an operative procedure for the relief of the patient. The diagnosis is occasionally quite obscure. The condition may arise from the malposition of any tooth. In a practice of more than a quarter of a century, I have seen encysted one after another, and in various positions, every tooth of the permanent set except the first molar. These positions follow no rule. I have seen a lower incisor with its crown under the skin at the point of the chin. An upper central lying horizontally just beneath the floor of the nostril. Laterals that simply failed to erupt, and laterals, cuspids, and bicuspids high up toward the orbit; cuspids deep in the jaw and lying across the arch with the crown toward the roof of the mouth, or the reverse. One of the bicuspids becomes encysted occasionally simply by being held between the roots of the adjacent teeth.]

Anomalies of Structure.

The crown of the upper lateral incisors is not infrequently stunted, and appears like a mere small point. Occasionally it is stunted only on one side. By union with a supernumerary tooth it is sometimes abnormally thicker upon its lingual surface. The cuspid is very seldom triangular. The third molars are occasionally of the size and nearly the shape of the bicuspids. Treatment is not resorted to for the correction of the anomalies of structure.

Occasionally the roots are present in abnormal numbers. In some cases I have found a lower cuspid with two roots, and three or four roots to lower molars. The upper bicuspids occasionally have two and three roots. Less than the normal number of roots are often observed on third molars (instead of three, or two, only one),

and on the upper second molar the lingual roots are sometimes united with the posterior buccal root.

The roots are subject to various abnormalities of form. Those of the lower molars are occasionally tortuous (See Fig. 7), and hence often difficult of extraction.



FIG. 7.—*Curved roots.*



FIG. 8.—*Diverging roots.*



FIG. 9.—*Crooked roots.*

This is also experienced when there is extensive divergence and crookedness of the roots. (See Figs. 8 and 9.) The upper bicuspids and cuspids occasionally have a bayonet-shaped curve of the root which makes their extraction very difficult. Both roots of the second lower molars are in some cases united on their buccal sides. (See Fig. 10.)

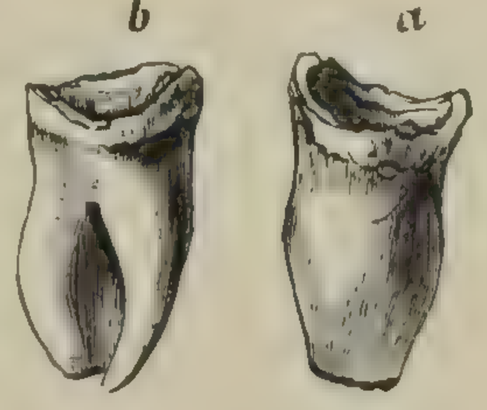


FIG. 10.—*a and b. Showing union of the roots on one side.*

In attempts at extraction this union frequently causes the forceps to slip backward, and unless much caution is exercised the molar back of it may be also dislodged.

Exostosis of the roots may be mentioned here. It generally occurs in the shape of a bulbous or cylindrical thickening of the apex of the root, and makes extraction difficult. In persons in whose cases difficulty has been experienced on this account in the extraction of one tooth, at future operations if attended with difficulty, it may be understood with almost certainty that exostosis is the cause. Aside from this one instance, deformities of the roots cannot be diagnosticated with any reasonable amount of certainty so long as they are imbedded in the jaw.

The temporary teeth show but few divergences, worthy of consideration, from their normal form. The molars of the temporary set have very diverging roots, and hence about the tenth year of age, when the permanent tooth has taken its place between them, they are sometimes very difficult to extract.

Osseous Union.—A tooth may be partially or wholly united with its adjoining neighbor, and that neighbor may be a normal or a supernumerary tooth. If two dental follicles unite, there results one tooth having the form of one of the two, and whose size is equal to both. Thus, for instance, occasionally the lateral incisor becomes a part of the central, which, therefore, is that much larger, but otherwise of normal structure.

In other cases the dental follicles merely come in contact, having the normal organs and the dental sac in common. In the fully-formed tooth we will find in this case the pulps of both teeth united. The enamel and the dentine of one tooth unites with that of the other, and the line of demarkation is shown by a groove.

Occasionally the external union of the pulps takes place only in the crown, while the roots are separate and distinct. In other cases the crowns may be separated, and the roots united—either by dentine and cementum, or only by cementum.

Osseous union is of practical importance in two respects: In cases in which the union is indicated by a longitudinal furrow or groove there is a temptation to separate them with the file. But this should not be done, because in these cases the pulps may be united. In cases of the union of the roots only, a condition impossible of diagnosis before extraction, the attempt to remove one tooth will result in the extraction of both teeth; such occurrences, however, are rare.

Sometimes teeth are found in which another, a smaller supernumerary, or an adjoining rudimentary tooth of the normal set may be partially included. In these cases the smaller tooth is only partially developed, the enamel and dentine organ having atrophied from the pressure of the surrounding dentine of the larger tooth. The root-portion of the smaller tooth is united with the larger one either by the periosteum or by the pulp.

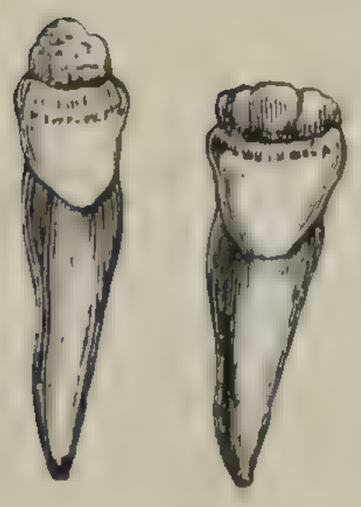


FIG. 11.
Grooved Teeth.

Enamel Defects.—The most frequent hereditary defects of tooth structure are classified under the term erosion, or atrophy of the teeth; such are grooved, honey-combed, scrofulous, and rachitic. (See Fig. 11.)

Sometimes there are pits, furrows and cross-grooves in the enamel of the incisors, cuspids and first molars; less frequently

these defects occur on the first bicuspids, and still less frequently on the second bicuspids;* they are the least frequent on the second molars and never occur on the third molars. Of the temporary teeth only the cuspids, premolars and molars show these defects, but less frequently than the permanent teeth. The latter may be free from them even when the temporary are not. In other cases the temporary as well as the permanent are defective, but in most cases only the permanent are so affected.

The small pits are the slightest grade of these deformities. They are not regularly distributed over the entire surface of the enamel, but appear in transverse rows, which are nearer the cutting edge than the neck of the tooth. If these pits communicate with one another a groove is the result. Such grooves occur singly, by twos, and occasionally three on one tooth, and between each of them the enamel is normal. Occasionally it occurs that the normal enamel is absent between the grooves, or the grooves may be connected with each other. There are also teeth in which one-half of the crown, nearest the cutting edge, is thin and uneven, and that nearest the neck is thick and covered by a normal layer of enamel.

The causes of these defects are somewhat obscure. Most probably they are the results of interruption of development. During the process of dentification there is an interruption of the formation of enamel; this results in a line of pits or a groove. Where there are a number of grooves, enamel formation must have been interrupted as frequently as there are grooves present; where a large surface of the tooth is covered with rudimentary enamel or none at all, the interruption must have continued for some time, as long as, perhaps longer than, the formation of the dentine of half of the crown was in progress. Nor is the dentine perfectly developed; its texture is incomplete, showing in many places interglobular spaces or contour lines; it is generally present in a thinner layer, yet its development is not so much interrupted, and its texture not as defective as that of the enamel. It seems that the enamel organ belonging to the epithelial structure, and nourished by the vessels of the connective tissue of the tooth-sac, suffers to

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*Parrot states that the second bicuspids and second molars are always exempt. Larger numbers of observation seem to prove that while they are much less frequently affected they are not entirely exempt. (See Parreidt *Zahnarztl. Mittheilungen*, page 104.)

a greater extent than the dentine organ that arises from connective tissue.

Exactly to what the causes of the interruption of enamel formation is due, is not fully ascertained. For a long time diseases of the skin have been supposed to be the cause, diseases to which children are supposed to have been exposed during the time that these teeth are in process of development. There is some reason for entertaining such a belief, since the teeth themselves resemble dermal tissues in so far as the enamel is homologous with the epidermis. But these defects also occur in persons who did not suffer from any diseases of the skin at the time when the dentine of these teeth, covered by this rudimentary enamel, was in process of formation. Rachitis is also said to be a cause, and since it causes marked changes in bone, it is very probable that its effects may be impressed upon the teeth. Nevertheless, persons are found who have suffered from rachitis, but on whose teeth there are no enamel defects; and on the other hand, these defects are present in persons who never suffer from rachitis. It must be remembered, however, that rachitis is very likely more frequent than it is diagnosticated; and often in later years parents, of children who have suffered from it, do not remember at the time when the defective teeth make their appearance, that they were thus affected in former years.

Magitôt says that convulsions of children are the cause of these enamel defects. He places these parallel with certain affections of the lens and the finger-nails, both of which are said to result from these convulsions. There is a probability of correctness in these theories, for the reason that a large number of persons in whom these enamel defects are observed have suffered from convulsions during the first few years of life, and also that only such teeth show defects that are developed during the first two years, at a time when convulsions are most frequent. The bicuspids and second molars, in which dentification begins during the third and fourth year, are seldom subject to these defects. Still, these cases occur, and I have positive knowledge of several in which defects were present, and the children were not subject to convulsions. Parrot has determined, that when an incisor has a defective surface of 6 mm. the child must have had 209,644 attacks of convulsions, as the period of each attack is but a very short space of time. Parrot himself believes the defects to be due to congenital syphilis. These assertions are erroneous,

however, as the greatest number of persons whose teeth show enamel defects are not subject to hereditary syphilis. On the other hand there are children that at a later period show other symptoms of hereditary syphilis, but whose teeth are perfectly normal. Magitôt could not find erosions in the Kabyles, of Algeria, in whom syphilis is epidemic; their absence was also observed on the skulls of Chinese, Japanese, Mexicans, Peruvians, races in which syphilis is very generally prevalent. From what we know of the subject there remains nothing for us to believe except that interruption of nourishment, to which the child may be subjected during the period of dentition, is likely to produce these defects. According to this, the grooves of these correspond with recurring disturbances of nourishment, and the defective surfaces to interruptions of a longer period. In accordance with this is the fact that rachitis, hereditary syphilis, and convulsions are often shown to have been present in children in whom these enamel defects appear; for rachitic children usually suffer from disturbed nutrition, as do those affected with hereditary syphilis, and convulsions frequently occur in consequence of diseases of the digestive apparatus.

Dentists have little opportunity to learn the true causes of enamel defects. The medical practitioner is in a better position to learn these causes, since in his capacity as family physician he becomes cognizant of the diseases to which the child is exposed during the first years of its life, and he could readily examine the teeth of these children at a later period.

The results of enamel defects are an ugly appearance of the dentures, and, by reason of the uneven surface, a greater liability to caries.

[A close study of defective enamel, and a comparison of the positions of the points affected with the time of the development of the several parts of the individual teeth shows, as a rule, that all of these that are present in an individual have occurred at one and the same time. That is, unless there is present more than one defective horizontal line upon individual teeth. These, if present, have, of course, occurred at different times, and the perfect enamel between such defects has developed in the interval.

These defects occur usually in horizontal lines, and may affect many teeth similarly, but will differ slightly in position upon the different teeth. Also, certain teeth are affected together, while

others escape. Thus, we often find the cusps of all of the first molars imperfect, and no imperfections upon other teeth. In another case we find associated with this a defect of the cutting edge of the central incisors. Now it is found that the calcification of these points begins at about the same time, about the time of birth, that of the molars usually preceding that of the incisors. Hence, they are often affected, while the incisors escape. If the difficulty has occurred a little later, so that the first molars are affected more deeply in their crowns, more of the cutting edges of the central incisors will be involved, and the mark will extend to the laterals also, for they have begun to calcify later, and hence escape entirely when only the extreme edge of the central was affected. In case the mark is as much as half-way between the edge of the central incisor and the gum, the first molar will not be affected at all, for its enamel was fully formed when this portion of the central incisor was being calcified. The line of defect will, however, usually be found to cross the laterals, cuspids, and one or both of the bicuspids, but rising toward the cutting edges or grinding surfaces as it passes backward. This is simply because these teeth have begun their calcification later, and upon each tooth the line of defect marks the part of the enamel that was being developed at a time when some notable depression of the vital powers occurred.

In the study of this subject I have carefully sought to learn from parents the time and nature of the illness of the persons that showed this class of defects in their enamel. In so doing I have obtained a history of illness corresponding in time with the calcification of the portion of the teeth affected in so large a majority of the cases, that I must suppose the history imperfect in case such illness does not appear. The gravity of the illness does not, however, always correspond to the extent of the injury to the teeth, yet in the main there is a correspondence between them. The character of the illness, the particular disease, seems to be as various as the ills that affect children. The result is one of suspended or temporarily imperfect nutrition, and in no wise an effect of a specific form of disease. Imperfections of the enamel of individual teeth, especially in the bicuspids, occur from local affections that disturb the enamel organ, as described later.

The black lines on the chart cross each tooth on the portion undergoing calcification at the ages indicated. They are as nearly

correct as I am able to make them after a close study of the observations recorded in our literature, and comparison with my own. It must be remembered that the lower teeth are generally a little in advance of the upper. Also, that there are differences in the time of development, the chart representing the average. The chart will be of use in determining the time at which faults in the development of the teeth have occurred; or in any case in which a knowledge of the advancement of any individual tooth, at a specified time, may be desirable.]

In treatment such prophylaxis is to be observed as is included in general hygiene of children. If the surface of the teeth is once injured by such enamel defects, more care should be exercised in cleansing the teeth than when the enamel is smooth. In addition to this the most prominent part of the roughness may be removed by grinding, using the dental engine with which all dental specialists are provided.

Aside from the typical enamel-defects that appear in regular transverse grooves, etc., there are also irregular ones, and these, generally, are most frequent on the bicuspids. They are very likely caused by the inflammation of the dental sac at a time when the temporary teeth, in consequence of decay and death of the pulp, cause a purulent osteo-periostitis of the alveolar process. These defects are the size of a lentil and larger. Sometimes the enamel is absent in an irregular extent from one-half of the crown.

Treatment is entirely prophylactic. If temporary teeth are present, which cause swelling, they should be removed. The defects themselves should be kept carefully cleansed, as they readily result in decay.

Syphilitic teeth.—Hutchinson has described a form of teeth that occurs only in persons affected with hereditary syphilis. They are often inadvertently confused with the defects of atrophy described in the preceding paragraphs. Syphilitic teeth may have perfectly smooth enamel; their characteristic is their dwarfy appearance, consisting in a convergence of their surfaces toward the cutting edge, thus resulting in a semi-lunar shape of the latter. (See Fig. 12.)



FIG. 12.—*Hutchinsonian Teeth.*

Sometimes only one of the incisors is thus mis-shaped, sometimes both, occasionally three of them and even four; infrequently

the first molar also. These teeth are not found, however, in all persons affected with hereditary syphilis, but when they are present they may be considered as positively diagnostic.

With the miscroscope defective development of the dentine may be discovered in teeth which show enamel defects, also on such as have a thin layer of smooth enamel; and this is especially true of teeth of a gray and grayish-blue color (Baume). The dentine defects consist of interglobular spaces, abnormally large dentinal canals, and the presence of unossified or imperfectly ossified portions (amorphous masses). Practically these facts are of importance, because in imperfectly formed dentine decay progresses more rapidly than in normal teeth.

Cementum is not subject to extensive anomalies. Resorptive cavities, or large spaces caused by the union of several lacunæ, and the presence of abnormally small lacunæ, are all that need mention in this connection.

Odontomes.—Odontomes are monstrous dental formations in which the dental structures are irregularly distributed. They are classified as soft or undentified, mixed or partially dentified, and hard or perfectly dentified odontomes.

Soft odontomes originate from a hyperplasia of the dentine prior to the commencement of dentification. This class is rare, and difficult to diagnosticate; some of them are fibrous, myxomatous, sarcomatous and cystous. The criterion of diagnosis, the presence of odontoblasts and enamel cells, is not easy of determination in such mis-shapen swollen masses.

Mixed odontomes result from hyperplasia of the tooth-germ after the commencement of dentification. They are readily diagnosticated from a pathological and anatomical point of view. The tumor contains portions of enamel and dentine in as many as twenty or thirty pieces with papillæ of the pulp and odontoblastic cells. These are also sometimes sarcomatous or cystous.

The hard odontomes are subdivided into those of the crown, of the root, and of the cementum. The first begin to develop before the enamel of the respective tooth is fully formed, because the enamel organ is involved herein, as is evident from the presence of irregular masses of enamel between the globules of dentine within the hyperplasia. There are, however, odontomes without enamel; in these instances it is to be presumed that by the excessive growth

of the dentine organ the enamel organs become atrophied. In the dentine-globules may be observed irregular pulp-chambers.

Odontomes of the root-membrane occur in those cases in which the dentine-organ and the dentinal sac become excessively developed after the entire formation of the crown. The roots in these cases consist of a large mis-shapen mass of pulp, dentine and cementum. (See Fig. 13.)

Cement odontomes are dental formations whose roots and crowns are covered by a layer of cementum from 3 to 5 mm. in thickness, due to the excessive osteoplastic activity of the dental sac.

Odontomes develop most frequently in the lower jaw from the germs of the second and third molar. They occur occasionally in the upper jaw, and sometimes originate from the germs of supernumerary teeth.



FIG. 13. *Root Odontome (after Ch. Tomes).*

The symptoms of an odontome are those of a benign tumor. Soft odontomes may be taken for sarcoma, cystic ones for common cysts.

The treatment for soft and mixed odontomes consists in partial resection of the jaw. Dentified odontomes can be sometimes removed in the same way as in normal teeth. In other cases part of the surrounding bony structures must be chiselled away in order that the monstrous dental formation may be removed.

DISTURBANCES OF DENTITION.

During the first dentition children often suffer from catarrh of the stomach, bronchitis, diseases of the skin, convulsions, etc. These troubles are often attributed, not only by the laity but also by physicians, to the process of dentition. In most cases, however, these diseases are due to other causes. I say in most cases, because in very few is the etiology of dental irritation clear. In cases in which the gums covering the tooth to be erupted are swollen, and of a dark red color, there can be no doubt that the child is suffering with dentitio difficilis, and in these cases reflex irritation of the nervous system may lead to inflammation of the bronchial and gastric mucous membrane. The other cases in which, without apparent inflammation of the gums, dentition causes reflex disturbances, it is claimed are cases of irritation of the matrix of the pulp and the

periosteum. The former is claimed to be pressed upon by the open end of the root, as soon as the gums become tenacious and hard, and hence do not readily yield to the pressure of the coming tooth, forced upward as it is by granulation tissue. The gums will be found somewhat swollen and red in these instances, or they may be in a hyperæmic condition. Treatment consists in lancing the gums in the cases in which the inflammation is marked, and the pain immediately ceases.* The bleeding is of no consequence in these cases, if the usual amount of care is observed. The mouth may be rinsed frequently with cold water.

Difficult dentition of the permanent teeth.—The permanent molars have no predecessors in the temporary set, and hence they erupt under the same circumstances as the temporary teeth, which also have no predecessors. Nevertheless, it is but seldom that any difficulties of dentition arise with the first and second molars, and reflex disturbances are still more uncommon. As these observations may be made in older children, who can readily point out the location of the pain, it must be surmised that first dentition would be the cause of disturbances but very rarely.

The third molar is an exception. Very often there is not sufficient room for it, and this is especially true in the lower jaw. The gum covering it is resorbed very slowly, and often injured in mastication by the teeth of the upper jaw; and this irritation leads to inflammation of the gums, which may continue until the periosteum of the alveolar process of the jaw and adjoining tooth is also involved. Pharyngitis may result, and an angina (dental) is a regular symptom of the difficulty of eruption of the third molar. The swelling in the region of the lower jaw is sometimes very severe, so much so that the patient cannot open his mouth; an abscess is formed, and the pus discharged alongside of the second molar, or near the cheek slightly anterior to the angle of the lower jaw. In these cases the fistula sometimes remains for years. In all cases of a swelling of the lower jaw the condition of the teeth should be

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* In the case of a child six months of age who was brought home one evening, because of illness which persisted even at a health resort, and who did not sleep any during the previous night, I found the next morning the condition described in the upper jaw, in the gums covering the central incisors. I lanced the gums, and the child immediately fell into a deep slumber, which lasted more than eight hours.

taken into consideration, and if there are no cavities it may be presumed that the eruption of the third molar may be the cause, in persons from twenty to thirty years of age, and in whom that tooth is absent. The diagnosis will be materially aided by probing under the gum for the hidden tooth.

If the pus is vacuated spontaneously, or after the incision has been made, all symptoms of acute inflammation will disappear, and the patient will only notice a slight difficulty in moving the jaws. Some swelling remains, however, and it may from time to time develop acute symptoms. In other cases the patient suffers simply from gingivitis and angina.

In order to prevent these difficulties of eruption, the first molar may be extracted in such cases as it is decayed so far as to involve the pulp. The second molar passes forward into the place of the first, and thus leaves sufficient room for the third. In certain steps of the inflammation of the gums a portion of the gum covering the tooth may be excised, which generally leads to an abatement of the difficulty. To allay pharyngitis, and in order to secure a shrinkage of the gum, a solution of alum may be recommended as a gargle. If an abscess is formed, lancing is indicated. If the case becomes chronic with recurring acute attacks, it is sometimes better to extract the second molar if that is decayed, thus giving sufficient room for the third molar. If, however, the second molar is in a healthy condition, it is better to extract the third molar; and only when it is entirely impossible to extract this, may one be justified in extracting the second molar, even if it be perfectly sound.

Disturbances of dentition caused by the eruption of the temporary teeth.—Frequently the permanent teeth erupt behind the temporary teeth, while these remain in their positions. The process of resorption in these cases is too feeble, and involves, as a general rule, only that portion of the root of the temporary tooth that is turned toward the permanent tooth. The temporary tooth in question must be extracted in these cases, and the little patient recommended to assist the coming tooth into its position by slight pressure with the finger, frequently exercised. In the case of the lower teeth they become regular very easily, as the tongue exerts a continual pressure on the irregular tooth, and hence it takes its proper position, obstruction having been previously removed by the extraction of the temporary tooth. In the upper jaw, on the contrary, it

is not so easy. If, for instance, an upper incisor erupts behind a temporary tooth, it is pushed back more or less continually by the occlusion of the jaws, the lower tooth articulating between the temporary set and the irregular permanent tooth. When the temporary tooth is lost, a vacant space remains, into which the permanent tooth cannot move of its own accord. In order to prevent the pushing backward of these upper teeth by the lower ones, a rubber plate should be worn, which should cover the gums and the masticating surfaces of the molars. Behind the retroverted tooth there should be a perpendicular piece of rubber, into which a screw is fastened, and this is daily turned so as to push the tooth out. Instead of the screw a small piece of compressed wood may be fastened into the plate, and it may be replaced daily by a larger piece. If there is sufficient space for the tooth, this may be brought into position in from a few days to a few weeks by an application of this constant pressure. If, however, there is not sufficient space, the adjoining tooth must be pushed forward and laterally in order to enlarge the arch.

The upper cuspid frequently erupts very far up, and outside of the arch, in cases in which the temporary cuspid was extracted too soon, and where the lateral incisors and the first bicuspids entirely fill the space. In these cases either the cuspid should be extracted when it can be grasped conveniently, or one of the bicuspids may be extracted, and thus make room for the cuspid; in those cases in which the first molar is very badly decayed it may be extracted, and the bicuspids pushed back, thus making room for the cuspid. To enlarge the arch in order that the cuspid may have sufficient room without causing the loss of any other tooth is advisable only in those cases in which there exists a wide space only needing enlargement. If the space is entirely closed, it is generally best to cause the loss of one tooth. Good appearance should always be sought for.

[In case room is to be made in the arch for one or more teeth that have taken a wrong position, the features of the patient should be studied with reference to the effect of expansion or contraction of the arch, and upon this the decision should mainly depend. In a considerable proportion of cases the arch will be found too small in one, or possibly two directions. First, the arch may be too narrow, so that the features appear pinched, and the expression of the face will be improved by expanding the arch laterally. Second,

the arch may be too short, so that the face has a flattened appearance in front, or the upper lip may appear sunken, and the nose too long for this reason. In this case room should be gained by moving the incisors forward. If, however, from a study of the features, it is found that the lips are already too prominent for the best expression of the face of the individual, then room should be had at the sacrifice of one or more teeth. In making this decision it should be remembered that at about the age of puberty, or after the permanent teeth have taken their places and before the features are fully developed, the mouth is apt to appear more prominent than in after years, and allowance made for the correction that comes from the completion of development.]

Disturbances of Resorption.—The resorption of the roots of temporary teeth ceases when the tooth is decayed, its pulp dead, and the dental canals are filled with the results of decomposition. The granulating tissue that would otherwise cause resorption spreads farther, and thus pushes the tooth backward and outward. In consequence of this pressure the labial side of the alveolar process is resorbed, and finally the gum is penetrated. The parents of the child generally think that the projecting apex of the root is the coming tooth; and apply to the physician for the purpose of having the temporary tooth extracted, with which, naturally, the projecting apex of the root is also removed. In other cases the position of the necrotic temporary tooth becomes more and more horizontal, and the root finally presses into the lip and causes painful ulceration. These teeth are readily extracted with the elevator after the division of the gums, by taking hold at the apex of the root. In the forceps such frail necrotic teeth generally crumble.

[Absorption of the roots of the temporary teeth does not depend upon their vitality. Roots of teeth that have lost their pulps are absorbed as readily as those with living pulps, provided the tissues about them remain in a physiological condition. If, however, there is alveolar abscess existing at the time absorption should occur, this process will fail. This failure is not on account of the condition of the root itself, but on account of the mal-condition of the soft tissues about it. Absorption being performed by certain connective-tissue cells, the odontoclasts that develop in contact with the surface of the root, it follows that if the root membrane be in a state of suppuration, or other condition that prevents the perform-

ance of its normal functions, absorption cannot take place. Furthermore, in order to perform the act of absorption the odontoclasts must lie in contact with the tooth's root. Anything whatever intervening is sufficient to prevent their action. Hence it occurs that, if the apex of the root is involved in abscess, and possibly a portion of its surface bathed in pus, no absorption can occur. In such cases, when the suppuration is confined to the immediate apex of the root, absorption may begin upon the sides and proceed from that point, cutting away that portion of the root toward the crown, leaving the apex unabsorbed. Such bits are occasionally found sticking about the necks of the permanent teeth. Some months ago a patient of mine was troubled by a small abscess, at the side of the root of an incisor, that had persistently refused to heal. On cutting down upon it for the purpose of exploration I found the point of the root of the temporary tooth.]

CHAPTER III.

DISEASES OF THE HARD DENTAL STRUCTURES.

Fracture of the Teeth.

A fracture of a tooth may take place either by direct force against the teeth, or indirectly by any connection sustained by the lower jaw. Frequently small pieces of tooth substance are broken off during mastication when hard substances are bitten. In one instance which I observed, a large piece from one of the lower healthy molars was fractured. This piece reached from the masticating surface to the gum and was sufficiently thick to include the lingual cusps.

In most cases, however, when the patients report that a piece of the tooth was broken off in mastication, and that afterwards the tooth became carious, the conditions were just the reverse: The tooth was first decayed, and during mastication the over-hanging enamel was fractured. From teeth that have been filled, occasionally small pieces of the tooth will fracture, and this is the case when decay has commenced at the margin of the filling, or in cases in which a weak margin was allowed to remain. If the tooth was very frail before it was filled, it may fracture and entirely crumble during mastication.

When a piece of a tooth is broken, pain in the dentine follows, especially so when in contact with cold water, or with sour or sweet substances. Such paroxysms of pain continue for weeks and even months, gradually diminishing, and finally disappearing entirely.

If the fracture extends to the pulp, severe pain is the result; this generally leads the patient to seek relief, which can be secured either by the destruction of the pulp or the removal of the tooth.

If the fracture extends so as to include part of the root, the loose portion sometimes remains attached by the gums, is held in position for a long time, and the pain is generally not severe. Fractures are usually horizontal or diagonal, when the force is brought directly upon the tooth. The loss of the fractured piece

causes a deformity. This class of fractures occurs most frequently in the upper incisors where the defect is most noticeable.

When the force causing the fracture is indirect, longitudinal, diagonal, and comminuted fractures usually result. Pain in these cases is often not so severe as we would expect, nor is the deformity so observable, for these cases generally involve the posterior teeth.

I have had an opportunity of observing a very interesting case of this nature in a young lady, in an accident caused by the running away of a team of horses. She was thrown from a rapidly moving carriage in such a manner that in falling she struck her chin on the paved street, causing a wound on the chin and the fracture of ten teeth (bicuspids, first molars and one cuspid). From some of the teeth only larger and smaller pieces were split off, while several of them were fractured their entire length into two halves. From the first upper right bicuspid the labial and lingual halves were split, and between the two was a growth of gum tissue 2 mm. in width. Four weeks after the accident two halves were still loose; seventeen months later, when I again saw the patient, they were firm. From the upper left first bicuspid the lingual half was split off diagonally so that it was held in place only by the gum. Nevertheless, the patient retained the tooth for seventeen months, when the presence of an alveolar abscess necessitated the removal of the tooth. The anterior right cuspid sustained a horizontal fracture, but the crown still remained attached to the gum on the lingual side for two years and a half. It was most remarkable that in this case the patient suffered but slight pain. Usually a single fracture involving the dentine causes so much pain that the patients are unwilling to retain such teeth, and when the pulp sustains injury such exceedingly excruciating pains follow that the patient is unable to rest, day or night. In this case, on the contrary, while involving ten fractures of which at least four must have involved the pulp, the pain was so slight that the patient did not seek relief until four weeks after the accident, and then not because of pain, but for the purpose of having the cuspid refastened, its crown being held only by a few fibres of the gum-tissue. Pain occurred only seventeen months after the injury, in the form of an alveolar abscess on the upper left first bicuspid.

In two cases of children at the age of two and a-half years I

observed three days after fracture of the upper temporary incisors a growth from the dental pulp the size of a hazelnut, and consisting of granulation tissue. The hyperplasia was removed with Paquelin's thermo-cautery, resulting in entire recovery.

In the treatment of fractures of the teeth the allaying of pain and correction of deformity should be sought.

In simple injury of the dentine the disappearance of the sensitiveness may be hastened by frequently touching the surface with a strong solution of nitrate of silver, or, when the discoloration is objectionable, a solution of chloride of zinc may be employed. If the pulp is injured it must be removed. This should be done by first removing a small portion of it with a sharp spoon-shaped excavator, followed by the introduction of arsenious acid, and on the following day the remainder of the pulp can be removed with a barbed broach. If the retention of the remaining portion of the tooth is not of much importance, its extraction should be preferred to extirpation of the pulp.

To remedy the deformity, if it only involves one-quarter of the length of the tooth, the adjoining teeth may be ground, and thus made shorter. If the defect is more extensive, it may be remedied artificially with cement, or by being contoured with gold. If the greater part of the crown is gone, sometimes it is best to extract the root, and with the aid of rubber bands close up the space by driving the adjoining teeth partly into it. This is generally to be recommended in cases of fracture of one of the lower incisors. In the upper jaw such a course of treatment generally more or less destroys the symmetry; hence it is preferable to retain the root, and to attach to it an artificial crown.

If the fracture extends within the alveolus, or if it is a longitudinal fracture, and the fractured piece is held in position by the soft parts, it need be removed only in case the gums become inflamed by the movements of the pieces, or when the pulp is very painful, and hence must be removed. If the pain is not severe the loose piece may be allowed to remain, since re-attachment may take place, not only in cases of transverse fracture within the alveolus, but also in longitudinal fractures, as was mentioned in the case previously cited. This is accomplished by callus, which is produced partly by the periosteum and partly by the pulp, and thus extends between the surfaces of the fracture from which previously some of the

dentine has been resorbed, and thus a strong attachment sometimes takes place.

[That fractured roots have occasionally been in some degree repaired by the deposit of cementum about the break, there can be no doubt. A considerable number of specimens that seemed to have been of that character have come under my inspection. I have never been so fortunate, however, as to meet with a successful case in practice, and am persuaded that, while success in obtaining union of such fractures is not without the range of possibility, it will be very seldom, indeed, that clinical results will justify the effort. In case of simple fracture of the root within its alveolus, with no exposure whatever of the injured parts, it would seem that repair by deposit of cementum might readily take place, particularly if immobility of the parts was maintained. But clinical observation shows that even in this case the pulp of the tooth has been so injured by the shock, or by the line of the fracture crossing it, that inflammation results, which is likely to lead to death of the organ through suppuration or gangrene, and thus defeat the process of repair.

In cases in which the tooth has been broken in the direction of its long axis, the line of fracture passing some distance into the alveolus, the tooth may be rendered comfortable by bringing the two parts firmly together by a gold band made to fit the tooth and set on as tightly as it can be conveniently driven. Any other operation can be performed afterward that may seem desirable, such as the removal of the pulp-filling of root-canal or of any cavity that may be present, It is usually best to set the band in some one of the cements. A considerable number of cases in this class of fracture treated in this way have, under my observation, rendered the teeth useful for a considerable time, some of them for four and five years. But generally I have not been able so to exclude the fluids from the line of fracture as to prevent fermentation and final destruction of the tooth.]

Exfoliation and Abrasion of the Hard Dental Tissues.

Enamel is of sufficient hardness not to be readily worn off in the mastication of our well-prepared food, and hence even on the masticating surfaces of the molars it remains intact for many years. It becomes worn more rapidly when using uncooked food. The teeth

are often worn in the course of years to such an extent that even the dentine is abraded, and finally the pulp exposed. In occasional instances such abrasions occur in civilized races, especially when, in consequence of caries, several of the molars have been lost, so that two or three teeth are obliged to perform the work of the entire set. In very rare cases the entire arch may be worn extensively even at middle age. A certain predisposition in these cases is supposed to exist. I recently saw a man thirty-two years of age in whom the crowns were half their normal length. In the case of a waiter twenty-eight years of age, whom I saw a few years ago, the teeth were all worn down to the gums.

Since, however, an abnormally poor structure of the dentine tissues cannot be noticed, it may be supposed that the texture is such that the small particles from which they are built are again readily separated. Such separation may be due to certain weak chemical agencies with which we are not yet familiar. The rubbing during the act of mastication suffices to remove the particles and leave the surface smooth.

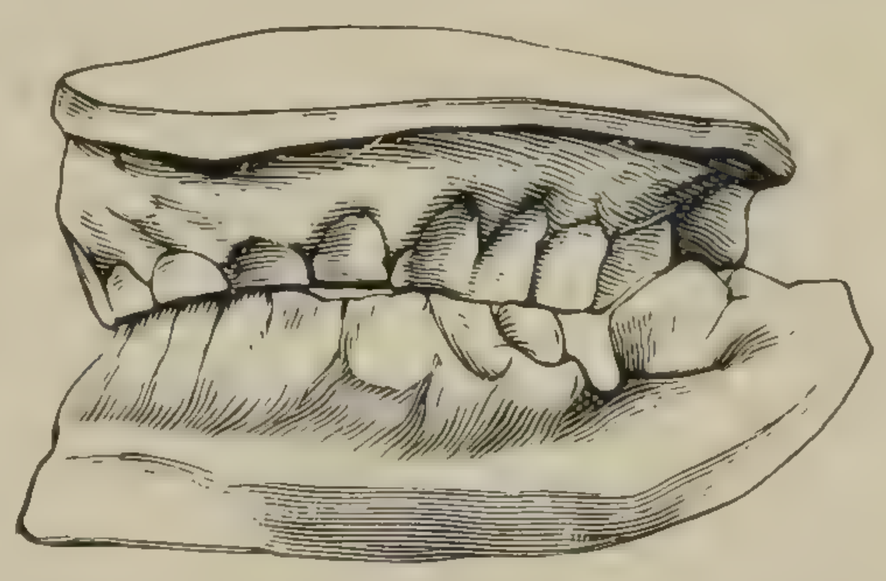


FIG. 14.—*Excessive Exfoliation of the Labial Surface of the Teeth.*

This abrasion is still more noticeable when the teeth on the labial surfaces, instead of on the masticating surfaces, are abraded, a condition observed in rare cases. I know a gentleman, forty years of age, whose teeth are abraded on the labial surfaces deep into the dentine. (See Fig. 14.)

The upper incisors have become so short from exfoliation (Baume) of the enamel and dentine that in articulating they do not come in contact with the lower teeth, and have not done so for a long time; hence trituration during chewing cannot be assigned as the cause. This abrasion resulted in a very apparent disfigurement, which led the patient to request me in 1881 to remove the firm, painless teeth, and replace them with artificial ones. I did not yield to his wishes. He was so persistent that in June, 1883, I decided to cut off the crowns of those most worn, namely, the upper right and left central incisors and the left lateral incisors, and to replace them by attaching artificial crowns into the roots. These operations were difficult, because the pulp was completely ossified, and the canal for

the reception of the pin had to be drilled in secondary dentine. It may be mentioned that the patient has suffered from chronic catarrh of the stomach for twelve years, and has frequently taken preparations of muriatic acid.

A similar case is mentioned by Baume in his "*Lehrbuch der Zahnheilkunde.*" In this case also, the patient suffered from chronic gastric trouble, but the peculiar condition of the teeth was observed before the gastric trouble, and therefore Baume can assign no reasonable connection between the two affections. I am inclined to the belief, in the case I cited, that the use of the muriatic acid proved to be the chemical agent that caused the separation of the small particles of tooth structure, while the movement of the lips polished the surfaces. The dentine of the exfoliated surfaces is always slightly discolored. Upon the masticating surfaces of the molars there is occasionally to be observed an acute exfoliation of the enamel substance, which is followed by a slower abrasion of the dentine. In these cases the latter is of a dark brown or black color, which has led these defects to be considered as caries, and the affection to be known as chronic and exquisitely chronic caries (Wedl). The origin of these defects is more in common with exfoliation than with caries. Occasionally there may be found carious cavities in the hard brown dentine, usually on the surfaces of contact, and in these instances they are generally deep. On the labial surface of the gums, especially at the necks of the incisors, less frequently at necks of the molars, never at the third molars, there may occasionally be observed a smoothly polished, wedge-shaped defect, which is also caused by chemical influences, but which may be the result of use of the tooth-brush or some other mechanical agency. The influence of the tooth-brush is often disputed, because in occasional cases similar defects occur in persons who never use the brush, and further, they are observed in animals. In the case of animals, however, the fact must be taken into consideration that the friction of hard particles of food often containing sandy substances and held by the soft parts against the teeth is of sufficient mechanical power to cause these defects, especially as it must be remembered that there may be some inclination to disintegration. This also occurs in persons who do not use a tooth-brush. That the brush undoubtedly plays an important rôle in causing these wedge-shaped defects is confirmed by my observations at the Polyclinic, which is

frequented mainly by such patients as do not use the tooth-brush, and in whom these defects occur very seldom, perhaps once in thirty thousand patients. In private practice, which is mainly made up of patients who give their teeth care, and who use the tooth-brush regularly, such cases occur frequently, about once in three hundred patients. The presence of a predisposition must naturally be conceded, as otherwise these defects would occur in several cases in which the tooth-brush is used. Nevertheless, I cannot refrain from warning any one from considering the tooth-brush injurious. To justify entertaining such a belief these results occur too seldom; and most likely when they do occur, caries may have existed had not the brush at the proper time removed the loosened particles of tooth substance, and thus retained the tooth in a polished condition. Micro-organisms most likely would have found lodgment among the loosened tooth-structure and led to caries. On the other hand, the brush may aid very much in preventing caries without causing the wedge-shaped defects, if it be not used with too much force, and if instead of being brushed horizontally, the teeth are brushed from the gums (in the lower jaw upward, and in the upper jaw downward.)

In all abraded teeth secondary dentine is formed at the periphery of the pulp nearest the abraded surface; hence exposure of the pulp does not occur readily. But in many cases this does not occur, because the dentine production on the near surface is less rapid than the consumption at the periphery.

Therapy has no remedy to prevent the unusual severe abrasion of the masticating surfaces of the entire set. If the loss of a number of teeth is the cause of an unusual abrasion of the remaining ones to such an extent that the dentine becomes sensitive, a partial denture may be recommended. In exfoliation of the molars (frequent on the first molar) it is only necessary to remove the sharp borders. Such teeth do not need to be filled, unless upon the exfoliated surface there be a carious cavity, which should be filled, but the remaining discolored hard dentine surface should not be interfered with.

The wedge-shaped defects should be untouched so long as they are not painful, but if they become deeper, so that pain results when in contact with cold water, it is recommended to fill the defects with gold or amalgam. In order to retain the filling it is necessary to

undercut the edges of the defects with fine burs used in the dental engine.

Caries of the Teeth.

Caries is that disease from which nearly all the diseases which are described in the following chapters result. In its consequences it has the greatest influence upon the well-being of the entire organism. A full presentation of the subject in this Compendium needs no further justification.

The Pathology of Caries.

If the dentures of a number of people are examined, in most cases there will be found one or more teeth having smaller or larger carious defects. According to my statistical examinations, which extend to over thirteen thousand decayed teeth,* caries may be classified in the following groups:

	Per Cent.
First inferior molar,	20.6
Second inferior molar,	14.1
First superior molar,	12.4
Second superior molar,	8.4
Third inferior molar,	6.7
First superior bicuspid,	6.3
Second superior incisor,	5.6
First superior incisor,	5.2
Second superior bicuspid,	5.1
Third superior molar,	4.3
Superior cuspid,	3.8
Second inferior bicuspid,	3.2
First inferior bicuspid,	2.8
Inferior cuspid,	0.6
Inferior lateral incisor,	0.5
Inferior central incisor,	0.4

Aside from this I have ascertained that 100 carious teeth on an average are composed of 26 incisors and cuspids, 28 bicuspids, and 46 molars. Of the incisors and cuspids, on an average 98 per cent. decay on the proximal, and only 4 per cent. on the incisive, lingual, and labial surfaces. The bicuspids also decay most frequently (92 per cent.) on the proximal surfaces, and only the molars decay most

*See Parreidt's *Zahnärztl. Mittheilungen aus der chir. Poliklinik.* Leipzig, 1882.

frequently (72 per cent.) on the masticating surfaces, while on the proximal surfaces the percentage is 28, and on the labial and lingual 2.

[In connection with this subject the publication of some tables recently prepared by Ottofy may be pertinent. The results have been obtained from the examination of the teeth of children outside of a dental practice, private school or infirmary, but in the Public Schools of American cities.

Of 5,100 temporary teeth examined, the following was the percentage of sound and carious teeth:

	Sound.	Carious.
Lower central incisors,	99.07	.03
Lower lateral incisors,	99.01	.09
Upper central incisors,	98.68	1.32
Upper lateral incisors,	98.58	1.42
Lower cuspids,	98.01	1.99
Upper cuspids,	97.22	2.78
Lower first molars,	93.48	6.52
Upper first molars,	93.28	6.72
Lower second molars,	92.20	7.80
Upper second molars,	90.23	9.77

Of 9,544 permanent teeth examined, the following was the percentage of sound and carious teeth:

	Sound.	Carious.
Lower cuspids,	99.99	.01
Lower central incisors,	99.96	.04
Lower lateral incisors,	99.95	.05
Upper cuspids,	99.95	.05
Lower first bicuspids,	99.90	.10
Upper second bicuspids,	99.72	.28
Lower second bicuspids,	99.70	.30
Upper first bicuspids,	99.62	.38
Upper lateral incisors,	99.45	.55
Upper central incisors,	99.15	.85
Upper second molars,	98.75	1.25
Lower second molars,	98.43	1.57
Upper first molars,	92.80	7.20
Lower first molars,	92.30	7.70]

The carious defects appear generally as cavities of various sizes, with irregular uneven borders. If the cavity is examined with a probe it will be found to contain decomposed particles of food and softened tooth-structure. In advanced stages the pulp may be pain-

ful during the examination; in cases still further advanced the pulp will be found partially putrified and the contents of the carious cavity emit a disagreeable odor. Pressure upon the tooth causes pain only in those cases in which septic decomposition of the pulp has occasioned inflammation of the periosteum.

If carious teeth are examined more critically, it will be discovered that the first appearance of caries is a chalky opaque spot in the enamel, in which the particles of structure are loosened. Gradually the enamel disintegrates into particles of chalk, which are removed and washed away.

Thus a cavity is formed, within which particles of food and micro-organisms accumulate and lactic fermentation is established. In the disintegrated enamel and dentine, also, various kinds of pigment are deposited (such as coffee, fruit, and the products of oxidation); thus by a slow disentegration a brown color results, which is wanting in acute caries.

When examined microscopically carious dentine presents a cloudy appearance, and the transverse lines within the prisms of enamel become distinct, and finally the prisms, or enamel fibres, crumble. Between the particles leptothrix will be found. The cuticula dentis is thickened, cloudy, speckled and torn, until finally it disintegrates.

In dentine, according to Baume, four stages are recognized. The healthy dentine becomes transparent, and this is the first indication of caries. The transparency is caused by the obliteration of the dentinal canals, and the obliteration, according to Tomes, is due to the calcification of the dentinal fibres. Baume* has shown that this is impossible. He believes the obliteration to be due to an expansion of the basis substances. On the other hand Walkhoff† has recently stated that such expansion could not lead to the narrowing of the canals, as the septa do not readily yield. According to his opinion transparency is the result of a process resembling sclerosis of bone structure, in which case an over-production of intercellular substance results, and the dental fibres become atrophied. The transparency of dentine occurs not only in carious teeth but also in secondary dentine, and quite frequently in the roots of senile but otherwise healthy teeth.

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* *Lehrbuch der Zahnheilkunde.*

† *Deutsche Monatsschrift für Zahnheilkunde, 1885.*

[In the formation of secondary dentine, so-called, if it is transparent, no dentinal tubes have been formed, or at least but very few; and otherwise the substance has little or no resemblance to dentine in the beginnings of caries, except in the one point of greater transparency than normal dentine. I have myself examined this condition in caries very closely and have come to regard it as an effect of the penetration of an acid, or the beginning of decalcification. I have satisfied myself that many of the appearances ascribed to this zone have been caused by the methods of preparation. The one condition of transparency is the only one that has been constantly found. This stage is followed very soon by widening of the canals, but before this occurs micro-organisms have already made their appearance. In the study of this subject it should be remembered that caries is in no wise a result of the physical presence of micro-organisms, but that it is a chemical effect of their products, *i.e.*, the acids they form, and that this acid precedes them and prepares the way for them to penetrate the dentine.]

The second stage of caries is characterized by a cloudiness of the structure. This is caused by rows of small round particles resembling strings of beads, which often occur as drops of fat during fatty degeneration of certain structures. This has formerly led to the belief that fatty degeneration of the dentinal fibrils caused the rows of small round particles. Baume has proved, however, that they do not contain any particles of fat, since they do not disappear when treated with ether. He declares them to be spaces caused by the shrinkage of the basis substance, and by the irregular expansion of the canals. Walkhoff, however, has found the canals regularly enlarged in a conical shape; he believes the cloudiness to be due to the dark appearance of the septa and the basis substance immediately surrounding them. The varicosities, in his opinion, are produced artificially by the dryness of the microscopical specimens; the cloudiness of the septa and of the adjoining basis substance is caused by the change of transmitting light through decalcified and through not decalcified dentine. According to this view, the first stage might be considered as the result of reaction, while the second stage may be due to the first effect of acid substances. Micrococci do not occur in either of the first stages of dentine decay.

In the third stage pigmentation is the most prominent symptom. This is said to result, according to Rottenstein and Leber, by

leptothrix becoming lodged in it; according to Schlenker it is due to the action of the micro-organisms; and according to Miller to the coloring substances of food. Baume declares the pigmentation to be due to the enlargement of the dentinal canals and their branches, which become expanded during the second stage. Walkhoff, nevertheless, still declares that the dentinal canals are regularly enlarged, and that the varicosities are occasioned by the drying of the specimen. Undoubtedly the tooth structure in the third stages of caries is much more porous and filled with micro-organisms from the loss of calcium salts.

In the fourth stage the softening of the dentine is complete, and microbes are present in large quantity. Miller* has cultivated from carious dentine five different kinds of fission-fungi which he has named the α–, β–, γ–, δ, and ε– fungi. The α–, β–, and δ– occur as cocci and diplococci, the ε– is a bacillus, and the β– fungus presents various forms of development, cocci, bacteria and bacilli. These microbes all possess the power of establishing fermentation in solutions of carbo-hydrates.

Decay frequently progresses very rapidly, to such an extent that sometimes within six weeks one half of a tooth may be destroyed. In these cases all the stages cannot be regularly distinguished from one another, and especially is pigmentation wanting. On the other hand, in chronic caries the anatomico-pathological appearances are especially prominent. In the majority of cases it requires from six to eighteen months for decay to progress from the outer surface of the enamel to the pulp.

Diagnosis is more difficult than might be expected, considering the location, and the seeming convenient access of instruments.

According to my observation the first appearances of caries occur in 64 cases out of 100 on the proximal surfaces of the teeth. These positions are sometimes covered by the adjoining teeth to such an extent that it is not only difficult for the eye to detect the incipient stage of caries, but it is also difficult to reach some of the defective points with the finest probes. Much care and experience is essential to discover decayed surfaces at the proper time, on the proximal surfaces of the teeth. In a full supply of natural light a small mouth-mirror (or a laryngoscope) is passed from tooth to tooth,

**Deutsche Monatsschr. f. Zahnh.*, November, 1884. [Also American System of Dentistry, vol. 1, p. 813.]

in order to discover any discoloration which may have taken place. In the spaces between the teeth saliva makes it difficult to find the minute defects. These must be wiped dry with a good quality of cotton, punk, or bibulous paper. As an examining probe a small hatchet-shaped excavator will answer, the same as are used for the removal of decay previous to filling. (See Fig. 15.)

With these instruments positions where decay is suspected to be are carefully probed and examined. If they do not enter a cavity or irregularity of the surface, but pass readily and smoothly over the entire tooth, such surfaces may be considered intact. Occasionally small particles of salivary calculus may mislead one to believe that a cavity is present, but forcible pressure with the instrument will dislodge the foreign mass.



FIG. 15.
Excavators.

In some cases before a proper examination can be made it may be necessary to separate the teeth, and this may be done readily by introducing a pellet of cotton and leaving it a day, at which time it is most likely that the instrument will enter and the presence or absence of decay can be positively ascertained. If the cavity is so large that the masticating surface has been involved and is broken, the diagnosis is readily made. Pain is seldom present in simple decay. At the beginning, as soon as the dentine is attacked, there is occasionally a slight unpleasant sensation or a mild drawing and gnawing pain when in contact with cold fluids or with sweet and sour substances, but this pain, which is generally of short duration, is not particularly heeded by the patient. The dentine is especially sensitive near the neck of the tooth. The contact of the tooth-brush with decay in these positions sometimes causes severe pain. Such dentine is designated as sensitive, and the condition is named hyperæsthesia of the dentine (Arkövy). If decay extends near the pulp pain is usually the result.

THE ETIOLOGY OF CARIES.

Although the teeth consist principally of a substance resembling bone (which is more dense, however), and which is covered by a still harder layer, they are nevertheless subject to a process of softening which is not known to affect bone; for dental caries is

essentially a different process of disease than caries of bone. In the latter case there is a multiplication of the cellular elements which causes disintegration of the hard bone-mass and a destruction of the new tissue. There have been attempts to explain dental caries in the same manner, but unsuccessfully. Dental caries is evidently a slow process of decay. A superficial consideration of this statement, subjects it to several objections. These are: 1, that in no other instance does decay occur on living organism; 2, that the enamel is so dense that it cannot readily decay; 3, that in the first stages of caries there have not been any micro-organisms found by any observers, all of whom are united on this point, and these micro-organisms are undoubtedly the cause of decay. These objections cannot be sustained when the circumstances are more carefully examined.

The life-energy of the teeth is at such a minimum that it cannot be of much resistance to the destructive energy of decay. A slight action may exist in the early stages exerted by the processes of the odontoblasts; but this is so slight that caries in pulpless teeth does not differ from caries affected teeth with living pulps—the resistance of the pulp, which exists in living teeth attacked by decay, always excepted.

The second objection, that the density of the enamel should be of some resistance to decay, is admissible to some extent. But frequently there exist defective portions in the enamel layer on the masticating surfaces of the molars, in which micrococci and substances, which are liable to decay and ferment, find ready lodgment. In these positions the surrounding enamel may be destroyed by the products of fermentation, and thus decay will ensue. In a similar manner fermentation results in the destruction of enamel between the interstices of the teeth on the proximal surfaces. The acids produced by the fermentation, cause decalcification, and finally an entire dissolution of the lime salts, and thus the slight amount of basis substance is readily destroyed. With the destruction of the enamel the decalcification of the corresponding layer of dentine is also in progress. The acids produced by fermentation cause the first and second stages of decay in dentine. In the third and fourth stages, when microbes are present, decay can only result after the lime salts are at least partially removed.

The various theories in regard to caries that have been enter-

tained, are the chemical, the parasitic, and the vital. It is erroneous, however, to accept only one or the other. During the carious processes there may be taken into consideration chemical as well as parasitic influences, and the slight vital reaction is not to be entirely ignored. The primary cause is unquestionably the fermentation of particles of food and of the thickened mucus on the surfaces of the teeth, which result in the production of acids; the latter in the nascent state loosen the lime salts of the tooth-structure. The third objection to the theory that caries is decay, that in the first stages micro-organisms are not found in the attacked structures, is overthrown by the statement that decay originates in the influence of an acid that precedes the entrance of micro-organisms. In the third and fourth stages, when acids have already removed some of the lime salts, micro-organisms have been found. These retain the conditions of fermentation and decay so that new layers are continually exposed to their influence.

Everything that tends toward the lodgment of fermentable particles upon the teeth is an etiological condition in the production of caries. The density of tooth-structure comes into consideration for the reason that the less dense the structures are the more potent the influence of the acids, and hence the more rapid the dissolution. In so far as a greater or lesser degree of completeness of the texture is hereditary, a greater or lesser disposition to caries is also hereditary. The liability to decay may be due also to some extent, to the fact that during tooth-formation the embryo, and later on the child, was not sufficiently nourished; and then again, that the child may not have properly used its temporary teeth for mastication, and thus acquired lassitude of the organs of mastication, which resulted in a minimum supply of nourishment for purposes of development. As a result the teeth are developed not alone poor in structure, but because the jaws have not been properly nourished they are also only partially developed. This leads to a crowded condition of the teeth, which in itself is favorable to the progress of decay. The proximal surfaces become convenient positions for the collection of fermentable substances, which cannot be readily removed either with the brush, the tooth-pick, or by the friction of hard food substances in mastication.

Hereditary enamel defects favor caries in so far as they give lodgment to micro-organisms and substances liable to ferment.

The whitish deposit which can be removed with a tooth-pick from around the necks of the teeth, and from between them, if they have not been brushed for a day, contains particles of food, mucus, dead epithelial cells, and micro-organisms. The most frequent form of the latter is the leptothrix buccalis. Besides these, Miller has found in the mouth the butyric fungus and acetic acid fungus, as well as many others, in all about twenty-five different forms of microbes. Most of them are capable of changing carbo-hydrates and sugar by fermentation into lactic acid. The collection of this deposit is one of the most direct causes of dental decay.*

[Aside from the substances mentioned above, there are some species of micro-organisms quite generally present in the mouth, which form a tough gelatinous substance that adheres quite tenaciously to the teeth, and in which the fungus develops its acid, which may thus be applied quite directly to the enamel. In this case its effects upon the structure are not mitigated by the washing of the saliva. In artificial cultivations of this fungus, I have often had a light beef-broth converted into a semi-solid, very adhesive mass, that would not run when the tube was inverted. This uniformly shows a strong acid reaction, even though the broth was mildly alkaline before the planting of the fungus. Thus it is shown, by this growth of fungi and their close application to the surfaces of the teeth, confining their acid products in contact with the enamel in positions in which it may remain undisturbed for some time, as between the teeth, and other points from which it is not readily dislodged, how the beginnings of disintegration occur.]

Sour food and medicines can influence caries only in so far as the short period of their presence permits them to attack the enamel. They are not so dangerous by far as the acids produced by fermentation in the interstices of the teeth.

Prolonged illness may lead to decay in many ways. First, the diminished nutrition must be considered; it causes the teeth to be

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*In a child two-and-a-half years of age, and affected with hydrocephalus, I had the opportunity to observe a highly acute and complete softening of all the temporary teeth. They were deprived of their lime salts, as if attacked by muriatic acid; retained their shape, however, and were covered by a tenacious deposit. As the child hardly ever moved its lips or tongue, the fermentation about the teeth had not been interrupted for an instant, for a period of some months. The consequence was the condition of acute caries just mentioned.

less able to resist destructive influences; and then the abnormal secretions must be considered: these are present in the oral cavity during fever. In a healthy person the acids produced by fermentation are at least partially neutralized by alkaline saliva. During fever the fluids of the mouth are generally acid. Hence the product of fermentation, lactic acid, is not made less destructive by the oral fluids, but, on the contrary, the acidity of these fluids aids in the destruction of tooth substance.

The indolence of the soft tissues toward the irritating influence of dead epithelial cells, and the diminished movements of the soft tissues during stupor, should be considered also. While in a healthy person the teeth are kept partially clean by the movement of the lips and the tongue, to the extent that on the lingual surfaces of the teeth decay is rare, and that on the labial surfaces it occurs very seldom; these movements are entirely wanting in the sick, and especially during severe illness, such as typhoid fever. In such cases fermentation about the teeth can progress without hindrance. Nor is it disturbed by the attrition of hard particles of food, since such sick persons are generally sustained on liquid nourishment. Neither is the most cleanly person inclined to use the tooth-brush during severe illness. Finally, acidified draughts and medicines may also add to the destruction of the enamel. Dental caries in young persons is of the same frequency in both sexes. [This statement does not wholly correspond with the views held by persons that have made observations, and gathered statistical information on the subject. While most observers have generally computed their statistics from persons of all ages, in this country, statistics relating to the prevalence of caries among children of both sexes, before puberty, have shown that caries prevails to the extent of 27.33 per cent. in males, and 32.67 per cent. in females. These figures were computed by Ottofy from the examination of fourteen thousand teeth of children.] At a later period the condition in the male is more favorable and principally because there is less desire for saccharine and farinaceous food, while this is true of the female; and also because the intervals between meals are less frequently interrupted by partaking of sweets. Of farinaceous and saccharine substances, particles collect about the teeth, and these are readily converted into lactic acid, and thus become injurious to the teeth.

The female is also at a disadvantage during pregnancy, at which

time a large quantity of lime phosphates are essential for the growth of the fœtus, and this supply is partly withheld from the teeth. It is well known that during pregnancy fractures heal less readily, because the lime phosphates are needed for the fœtus. If in a similar manner the nourishment of the teeth is affected as during the healing of fractures, one may readily conceive that their power of resistance against unhealthy influences must be materially diminished. It should be remembered also that pregnant women seldom suffer from hyperæmia of the gums and from abnormal secretions of the mucous and salivary glands. The re-action of the oral fluids during pregnancy is not infrequently acid. Finally, in these cases the reflex disturbances of digestion should be considered also, for the acid eructations are also injurious to the teeth.

Therapeutics of Caries.

Prophylaxis should begin with the embryo. It has been suggested that pregnant women should be given phosphate of lime in order that the teeth of the embryo may become perfectly developed. It is a question, however, whether the phosphate of lime is really assimilated, and whether it is of benefit to the embryo; and if this is the case whether it is not likely that the osseous frame of the child becomes so large that in consequence difficulties may arise during parturition. Undoubtedly the method of diet, as it influences tooth formation, may be considered generally with the influences of dieting and hygiene in general.

Lime-phosphate has been given to infants with a view of strengthening their tooth structures. If the influence of the phosphate is not unfavorable there may be no objection to the practice. Instead of lime-phosphate limé-water may be given. But when a child is otherwise properly nourished it would be superfluous to resort to remedies. A very erroneous impression prevails, that the poorer classes have better teeth than the rich. I can prove the contrary. In the surgical Polyclinic at Leipzig, in which more than three thousand patients are treated annually, I have made the observation that the teeth of the poor are in a worse condition than those of the rich, as observed in private practice. The most probable cause is undoubtedly negligence, in so far as the teeth are concerned (for the necessity of proper care is not yet universally understood), but the second important reason is undoubtedly the insufficient

nourishment of the children of the poor. To suckle the child themselves is often impossible for women in these grades of society, because they are too poorly nourished; and when possible it is of not sufficient benefit, because these poor women are compelled to labor without receiving sufficient nourishment. The artificial nourishment of infants among poor people is lacking to such a well-known extent that the larger percentage of these children die during the first year. The surviving ones suffer so much from neglect that possibly a strong denture cannot be developed.

During the first year, prior to the eruption of the temporary teeth, the first permanent molars as well as permanent incisors and cuspids are in process of dentification; hence, nourishment at this time already exerts its influence upon the permanent teeth. Diseases of the first and second year of life often leave visible marks in the shape of erosions on the permanent teeth as the result of insufficient development.

As soon as the temporary teeth are erupted the child can use them, and does so with pleasure. The child can be fed not only on mushy substances, but it can masticate bread and partially-chopped meat. The mouth of the child should be kept clean from the time of its birth; if teeth have erupted they should be cleansed daily, at least once, with a moistened cloth. This should be continued until the set is complete, at which time the use of the brush should begin. If daily cleansing is neglected during the first and second year of life, the foundation of a hopeless and too early ruin of the temporary teeth is often laid. An older child should never be permitted to leave the crusts of bread at a meal, or to dip biscuits in coffee. The permanent teeth become stronger, and the jaws are developed more fully if the temporary teeth are used to a proper extent.

In order that the child should not suffer from tooth-ache, and that it should not be prevented from masticating hard substances by an early loss of the temporary molars, which are shed between the age of ten and twelve, it is necessary to have the teeth examined from time to time, about three times a year. In this way the smallest cavities are discovered, and can be filled before any pain occurs. The distal surface of the first molar and the mesial surface of the second, especially, should receive careful attention during the examination. If the smallest cavities are filled immediately, before they are large, the child suffers no pain during the operation, and is

not liable to suffer from tooth-ache at a later period. It has no fear of the dentist, and the temporary teeth are preserved until the proper time for shedding has arrived; that is, until they drop out after the resorption of the roots, and thus make room for the permanent teeth.

The treatment is different if the proximal surfaces of several of the molars are entirely destroyed, even though the child has not yet suffered from pain. The destructive process may have encroached almost on the pulp, the operation is tedious, tiresome and trying to the little patient, and not infrequently very painful. It often happens that in children from four to five years old all the proximal surfaces of the eight molars are destroyed. The defects appear very small to the laity, but are usually large and difficult of treatment. If in addition to this the child is frightened and awkward, it is a difficult task to give proper relief. In these cases best results are attained by a conservative method of treatment; it is of the greatest advantage to the small patient to fill those teeth that are not very badly decayed, while those in very bad condition should not be disturbed until they cause pain, when the pulp may be cauterized; and this method be preferred to the filling of the tooth or its extraction.

The apparent contradiction of opinion on this subject among dentists is explained by the fact that in one instance a conservative treatment of the temporary teeth is recommended, while another dentist, under entirely different conditions, does not recommend any attempt to save the temporary teeth. It is entirely useless to attempt to fill such temporary molars as have given pain, if the children are between nine and eleven years of age. To recapitulate: The preservation of the temporary teeth, until they are replaced by the permanent, is of great importance; it is made possible only if the child brushes and cleanses its teeth regularly twice a day, beginning at the age of three years, and if the teeth are semi-annually subjected to a proper examination; that notwithstanding all possible cleanliness, cavities that may have been formed may be found in good season, and they should be filled before they are larger, more numerous, or painful.

By these periodical examinations it will be ascertained whether the permanent teeth are erupting in their normal positions, and by the timely extraction of such temporary teeth as may be retained beyond their usual time, the operator seeks to effect a self-regulation

of the permanent teeth. If an appliance is necessary it should be employed as soon as practicable.

The first molar, which erupts at the age of seven, is frequently mistaken for a temporary tooth. It is readily recognized by its sharp cusps, while those of the temporary molars are somewhat worn. It should be remembered also that, beginning at the median line, the sixth tooth on each side is a permanent tooth. The texture of the first molar is often inferior. At the eighth year it is frequently decayed, and at the ninth year decay very often extends so far as to involve the pulp. It is not advisable to fill a tooth of inferior structure in which decay has thus far progressed, but to extract it. If filled, it is most likely that decay will take place in other positions; at any rate, if such a tooth is to be saved it will require much care. In several cases in which extraction at a proper time was objected to, I have filled the teeth five and six times, several times on the masticating surface, then on the mesial and distal surfaces, and finally on the buccal. Then, too, there is much likelihood that particles of the tooth between the fillings will break off, and again require new fillings. Notwithstanding all this care, the crown built of such inferior structure is often lost within five or ten years. The space where the tooth stood cannot be obliterated by the adjoining teeth. The second molar leans forward so that in mastication the entire masticating surface does not articulate with the teeth of the corresponding jaw, but only on its posterior angle.

If the first molar is extracted before the age of twelve, the second molar will take its place, and at a later period the third will move into the space of the second. In this case no space remains; the denture is less by one tooth, but the arch is unbroken. This shortening of the arch has an advantage. As has been mentioned, the eruption of the third molar is frequently attended with much pain, but only when there is not sufficient room for it. Such difficulties of dentition are prevented by the shortening of the arch. Another advantage of this shortening is found in the fact that the third molar gets a better position, one in which it does not so readily become diseased as when located at the angle of the jaw, where it is of but slight service in mastication, and where it is difficult to reach with the tooth-brush.

Should, however, the first molar be of good structure, but the second, which erupts at thirteen, be badly decayed before the fif-

teenth or sixteenth year, it may be extracted for the same reasons, that the third molar, which erupts at nineteen, may move forward and take its position. If the first and second molars are preserved, and the third molars are carious within a few years after their eruption, they may be extracted; when they are so far back and so early diseased their conservation requires much care, and their use in mastication is limited.

In all other cases filling is generally preferable as soon as defects may be observed, and in order that the defects may be found before they become extensive, the teeth should be examined until the twenty-fourth year of age, at least three times a year, and after that at least twice a year. If patients look for aid only when tooth-ache compels them to, the saving of the teeth is attended with more difficulty. The periodical examination of the teeth by good dentists is one of the main features of prophylaxis. The daily cleansing of the teeth is still more essential. This is not always done in the proper manner; it is not sufficient to brush the teeth horizontally across on their labial surfaces as is usually done. In addition to that, the masticating surfaces as well as the lingual surfaces should be cleansed. It is most essential, however, to brush the proximal surfaces; since it is well known that here, generally, and not on the labial surfaces, destruction commences. In order to reach the interstices the brush should be moved from the gums toward the masticating surface; the lower teeth should be brushed from below upward, and the upper teeth from above downward. To the beginner this may be difficult, but he must not desist; in a short time one will become accustomed to it.

Tooth-brushes are of various forms. In addition to the simplest kinds, having a straight handle in which the bristles are of the same length, there are others with curved handles in which the bristles are of various lengths, and these are claimed to be of better construction for the purpose of reaching between the teeth and into those that may possibly be decayed. Decayed teeth, however, should not be present in a properly kept mouth, and the proximal surfaces of sound teeth are readily accessible to the bristles of a brush of simple construction if used vertically in brushing. If it were necessary to have different shaped tooth brushes for the purpose of reaching these various localities, one would be obliged to possess several brushes. Very few would do this, and it is not necessary.

The tooth-brush should not be too stiff, that the gums may not be injured. In brushes that are too soft the bristles readily drop out, and are not sufficiently strong for thorough cleansing; and if they are moistened they become still softer; hence medium brushes are generally preferable. After use the tooth-brush should be cleansed, dried, and hung up, that the water may entirely run out of it.

Brushes made of rubber have been placed on the market; these are said to have the advantage of not injuring the gums. But they are not sufficiently stiff, and do not remove the deposit from the teeth, but simply distribute it about them, and thus cause a loosening of the gums from around the necks of the teeth. Medium brushes, however, do not injure the gums if the latter are not in a hyperæmic condition from negligence. Notwithstanding the utmost care, it sometimes happens that the teeth become diseased. On the other hand, there are persons that never use a tooth-brush, and that have comparatively few diseased teeth. These two conditions placed side by side lead to the belief that care of the teeth is useless. But the influence of other causes should be considered. Those whose teeth decay in the face of the utmost care, would doubtless have more cavities, find their teeth in a far worse condition, if no care had been bestowed upon them. Teeth are not all alike; white, bluish, and gray teeth readily disintegrate. If they receive no care at all between the ages of twenty and thirty, the complete set may be ruined; while with intelligent care they may be retained until old age, except perhaps an occasional loss.

Yellow, dense teeth sometimes seem almost indestructible, yet they are liable to destruction. Generally, if carefully examined, defects will be found on the molars. These teeth remain naturally in as good condition, even without care, as teeth of an inferior structure that receive the utmost attention. If teeth of a dense structure are kept perfectly clean, as they should be, decay is an exception.

A frequent objection to brushing the teeth is the ready bleeding of the gums. As a matter of fact, however, proper brushing of the gum hardens and makes it healthy. If brushed thoroughly at least once a day, the gums will not bleed. But when neglected, even for one day, the gum is loosened and irritated by the collection of a deposit containing fermentable substances, and hence when in contact with the brush it bleeds. It is therefore to be recommended in

such cases in which the gums readily bleed, that the slight loss of blood should not be taken into consideration, and the teeth and gums be brushed thoroughly every morning and evening with a medium brush. If there is no disease of the gum, the bleeding will cease in four to six days.

Another objection to the use of the brush by the laity originated in the erroneous idea that it removes the enamel. The enamel may become thinner in course of time—continual dropping wears away a stone—but a human age is not sufficient to permit of the entire removal of the enamel by brushing the teeth twice a day. Where the enamel is worn off (and such cases are rare) other causes generally exist. The wedge-shaped defects referred to in previous chapters do not arise by the removal of the enamel, but of the cementum; and these can be prevented to some extent by brushing the teeth vertically instead of horizontally.

Tooth-powders and Tooth-soaps.—If sufficient time is used, a tooth-brush and water will suffice to cleanse the teeth. It is more advisable, however, to create some additional friction by using some kind of powder. The tooth-powder should be of such a fine grain that the fingers cannot detect any gritty particles. It should consist of alkaline substances. If it contain acids, it will cause the destruction of the tooth-structure, especially around the necks of the teeth if the gum has receded. Substances that may injure the teeth should not be constituents of a tooth-powder; alum, camphor, chloride of lime, etc., are some of these. Nor should any substance in tooth-powder be of such nature that by its presence in the mouth for any length of time it would change so as to acquire destructive qualities; thus sugar of milk, which as such is not injurious, readily changes into lactic acid, and if any has remained between the interstices of the teeth its effect will be harmful.

In addition to alkaline constituents the presence of antiseptic substances in tooth-powder is desirable. There may also be some substance that has a slight astringent effect on the gum. For this purpose are employed: cinchona bark, orris root, calamus root, sage leaves, etc.; and finally, there may be added some substance of a pleasant odor and pleasant taste. The color of tooth-powder is determined by its component parts, and as the mixture is generally of a grayish, unsightly appearance, some pink coloring material, such as carmine, sandal-wood, etc., is added. If all these require-

ments are considered, it will be seen that some otherwise useful tooth-powders are not appropriate.

Charcoal or charred bread are antiseptic, and have the quality of friction; but they are rather harsh, and a powder containing them should not be employed if the gums begin to recede. Aside from this, charcoal should not be used in tooth-powder because its crystalized particles become buried in the gum, giving it a bluish or black border that never disappears. The so-called Chinese tooth-powder, consisting of powdered oyster shells, cuttle fish bone, shave grass and pumice stone, has also a too decided mechanical effect.

Of substances containing acids, cream of tartar is generally used. Its effect upon the teeth is decidedly destructive; and this is also true of phosphoric acid, which is sometimes present in tooth-powders.

For some years salicylic acid has been added to tooth-powders as a free acid. This certainly is of undoubted value as an agent for retarding decay and fermentation, and has at the same time a pleasant sweetish taste, but its principal disadvantage is its destructive action on the teeth.

If a tooth is placed in an aqueous solution of salicylic acid, within an hour or two it loses its gloss and has a chalky appearance. In twenty-four hours the softened enamel can be scraped off with the finger-nail. This loose layer is not a deposit from the solution, for before being scraped off the tooth has lost in weight. I have also shown that after the experiment the solution contains phosphate of lime.* Even if these experiments have no further connection with the conditions present in the mouth, it cannot be refuted that an acid showing decided power of destruction within an hour is almost certain to be injurious in course of time, if used in the mouth. On the labial surfaces destruction may not be extensive, because the lips in their motion will remove the acid; but between the proximal surfaces of the teeth injury to the enamel, culminating in caries, must certainly follow if any of the salicylic acid powder finds lodgment. What is endeavored to be prevented by the addition of salicylic acid, namely the destruction of the tooth-substance by preventing fermentation, is the very thing that is established. Hence it may be stated as a certain fact, that salicylic acid as a constituent of tooth-powder is more injurious than beneficial.

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* *Vierteljahrsschr. f. Zahnh.* 1876, Band 4.

If a substance possessing the property of preventing decay and fermentation is to be added to tooth-powder, thymol is preferable, because it has no destructive property that can affect the teeth. I do not consider the addition of any such substance important. If the teeth are carefully brushed, fermentation around them is almost entirely prevented. The most useful properties of a tooth-powder may be found in prepared chalk. If the gums are to be benefited and the taste also improved, some finely pulverized orris root and a few drops of oil of peppermint may be added, according to the following formula:

℞ Cretæ prepar. 25.0 grams.
Rhiz. Iridis 15.0 "
Ol. Menthæ pip. 8 gtt.

Instead of powders, soap is sometimes employed in cleansing the teeth. The tooth-soaps and tooth-powders on the market are generally good preparations. But the simplest method is to recommend medicated soap. Many dentists consider soap as good as powder. Personally I believe powder to be the better, because it appears to me that soap favors recession of the gum. It certainly readily dissolves the epithelial cells of the mucous membrane.

Mouth-washes and tinctures are claimed to possess the property of conserving the teeth, to have a refreshing influence on the gum, and at the same time to remove any taint of the breath that may be present. The use of mouth-washes and tinctures is not essential. Under no circumstances should they be resorted to instead of brushing the teeth, though they may be employed as adjuncts.

Eau de Botôt is very popular, and a mixture of tincture of myrrh and cologne, a teaspoonful in a half tumbler of water, is also pleasant. For its power of oxidation, and hence its disinfecting quality, permanganate of potash is frequently employed. It is prescribed in bulk and a few crystals are placed in a tumbler of water; the solution should have a rose-colored tint. Carbolic acid and thymol are as effective as permanganate of potash, but these are not popular on account of their taste. Whoever is pleased with the taste of thymol mouth-wash should use it, for it is certainly beneficial. The best antiseptic for the disinfection of the mouth at the present time is bichloride of mercury. According to Miller's experiments*

**Deutsche medic. Wochenschr.*, 1885, Number 32.

the oral cavity should be rinsed with a solution of 1 to 2,500; the bichloride will effect a complete sterilization within from half to three-fourths of a minute, and in order to obtain the same result with permanganate of potash 1 to 4,000, must be used, and over fifteen minutes are necessary. Though the bichloride may be objectionable by reason of its poisonous properties, and hence cannot generally be recommended as a mouth-wash, I nevertheless believe that it may be recommended to cautious persons without hesitation. The amount of bichloride that may be absorbed by rinsing the mouth with a solution of from 1 to 3,000 to 1 to 5,000 is certainly of no consequence. Personally I use a solution of 1 to 1,000 for cleansing my tooth-brush before brushing my teeth, with the intention of destroying any fungi which may develop on the brush from day to day.

A more potent antiseptic than carbolic acid, is salicylic acid, but it is not desirable because it attacks the enamel. The same is true of benzoic acid, which is less antiseptic than salicylic acid.

Alkaline mouth-washes have a favorable effect because they neutralize the oral fluids in case they are acid. They are especially useful during disease and during the grape-cure, when the teeth are very much affected (Schlenker). Lime-water, solution of borax, or bicarbonate of soda in solution may be used, when alkaline tooth-washes are indicated.

Tinctures intended for use in the mouth consist principally of alcohol, with the addition of various substances such as tannic acid, myrrh, acetic ether, peppermint oil, spoonwood extract (Cochlearia), etc. They are unnecessary in a mouth otherwise kept clean.

The most effective treatment of caries consists, as has been already stated, in filling—that is, in the removal of all diseased portions and the filling of the cavity with the least destructible substance (see Chapter X). In exceptional cases, when decay does not extend into the dentine, but only into the enamel, it is sometimes sufficient to simply remove the diseased parts with sharp chisel-shaped instruments and files, and to shape the tooth so that no food can remain attached to the surface thus treated. For this purpose there are used stones, diamond-disks and various polishing instruments that are used with the dental engine. The filled surface must be polished perfectly smooth.

CHAPTER IV.

DISEASES OF THE PULP.

Hyperæmia of the Pulp.

The most frequent cause of hyperæmia of the pulp is caries, especially when it encroaches upon the pulp. The pulp then reacts to temporary irritation, such as pressure, cold water, cold air, acids, sweet substances, etc., because the protecting dentine is absent and the pulp becomes temporarily congested. The pain continues but a short time, from a few minutes to two hours, and sometimes does not return for days and weeks, while in other cases after the first irritation there are daily recurrences. If caries does not progress, but the irritation becomes more intense and frequent, and when, finally, bacteria reach the pulp, hyperæmia merges into inflammation. In these cases pain appears spontaneously, and usually during the night.

Hyperæmia, which may entirely disappear, sometimes again recurs from injury to the dentine, or after filling. Very often a filled tooth is painful for several days when in contact with cold water, even if the filling does not extend more than half through the layer of dentine. The injury to the dentine that takes place during excavation of the carious mass and disconnection from the healthy portions, causes irritation of the pulp; hyperæmia, which gradually disappears, is the result. If the filling extends to the vicinity of the pulp, the irritation and hyperæmia may continue for weeks and months.

[Hyperæmia of the dental pulp is frequently caused by exposure of the teeth to thermal changes, to which the pulp is normally very sensitive. This condition may occur in teeth that are otherwise perfectly normal, *i.e.*, teeth that are not carious in the least, and may increase by repeated exposures to violent thermal changes, until stasis occurs, and destruction (infarction) of the entire pulp may be the result. Hence, we not very infrequently find pulpless teeth that are otherwise perfectly sound. In addition to the causes of

hyperæmia given above, the careless use of the rapidly revolving disk in finishing fillings should be mentioned. In the use of the sand-paper disk, now so general in this country, especially when the rubber dam is in place (and the tooth is dry), a very considerable heat is quickly developed and the pain is likely to be immediately severe, causing an outcry on the part of the patient. In this way, in the finishing of even small fillings, or in polishing rough surfaces of otherwise healthy teeth, a condition of hyperæmia of the pulp is precipitated in a moment, that may require weeks or months for recovery, or may even result in infarction and death of the organ.]

The treatment of hyperæmia of the pulp, if caries is the cause, consists in filling the cavities; precaution should be taken that the pulp does not become infected during the excavation of decayed masses; this should be done under antiseptic precautions.

For the purpose of properly cleansing the cavity the very first step consists in enlarging the opening in the enamel. Measures to exclude the saliva must be then adopted, so that none may enter the cavity during the succeeding stages of the operation. The carious mass is then carefully removed with sharp excavators in such a manner that at first only that surrounding the walls is removed and the decay covering the pulp is removed last. Before the removal of each layer the cavity should be disinfected by moistening it with a pellet of cotton dipped in a five per cent. solution of carbolic acid. The advantage of this method is due to the fact that the pulp, in case of exposure and possible injury, is immediately flooded by this solution. The excavator also should be dipped in a five per cent. solution of carbolic acid. The nearer the operator gets to the pulp, the greater is the precaution to be observed not to injure it.

After the cavity is entirely cleansed under these precautions, I place within it a pellet of cotton dipped in a five per cent. solution of carbolic acid. This is permitted to remain until a small quantity of plaster-of-paris is mixed with a similar solution; this mixture is intended for the protection of the pulp. When the cotton is removed, the paste should be ready and held on a spatula near the cavity, that but little time may intervene between the removal of the cotton and the introduction of the paste, exposing the pulp for as short a time as possible to the atmosphere. The cavity is not wiped out before the introduction of the plaster-of-paris, as it contains

only carbolic acid and water, the same as has been used in mixing the plaster. The latter is gently pressed into position with a small piece of punk held by the pliers. From this moment the pain ceases. If too much plaster has been used, the superabundance is removed from the walls of the cavity and a dry piece of cotton is placed therein, to remain until all preparations for the filling are completed; then the cotton is removed, and the cavity is made perfectly dry with a hot-air syringe. During this time the plaster has hardened, so it will not crumble while the cavity is filled with cement or amalgam. If the tooth is to be filled with gold, I consider it essential to introduce a temporary stopping of cement, because of the great amount of pressure necessary to condense the gold. After about three months so much of this is removed as is necessary to secure good anchorage for a gold filling.

[In the treatment of most of these cases I think it better to apply an oxyphosphate covering at once. However, in cases in which there has been much pain it is well, after excavating as above described, and properly disinfecting, to apply a pellet of cotton saturated with a chloroform solution of gutta-percha, and allow this to remain for a day or two, or until there is relief from pain; it may be changed readily if for any cause this becomes desirable.

The application of the oxyphosphate covering is done as follows: when everything is ready as above described, a piece of ordinary writing paper is cut in such shape that it will readily pass into the cavity and cover all the deeper portion of it. Then a little of the oxyphosphate paste is quickly prepared upon a porcelain slab that has been heated to about 110° Fahr. (43° Cent.), and when just stiff enough to retain the form of a ball by careful manipulation, it is caught up on the paper and quickly transferred to the cavity, placing the paste so that it will be covered by the paper. Then by gentle pressure at different points on the paper the paste is brought in contact with all parts of the cavity it is intended to cover. In case the pulp is fully exposed, the adaptation of the cement to the pulp and walls of the cavity must be done with great caution, to prevent too much compression of the pulp-tissue.

When this has hardened sufficiently (in about ten minutes) the surplus may be removed, and the cavity put in condition to receive a gold filling, which may be inserted at once, or some kind of temporary filling may be made (preferably of ordinary trial-plate

gutta-percha), and the gold or other permanent filling deferred to such time as may be thought best.]

There are some difficulties when the cavity is on the distal surface of bicuspids or molars, and when it extends beyond the margin of the gum. It is not permissible under any circumstances to permit the border of the cavity near the gum to be covered by plaster-of-paris. Nor should any of the latter be so much removed that the pulp is not sufficiently covered and protected. Occasionally it is best in these cases not to rely on the preservation of the pulp.

The introduction of an antiseptic and non-metallic substance between the pulp and the filling proper is essential, even though the pulp may not be entirely exposed but only covered by a thin layer of dentine.

In place of the carbolic acid and plaster-of-paris that I am in the habit of using, some practitioners use oxide of zinc mixed with a solution of chloride of zinc, to which is added carbolic acid, iodoform, bichloride of mercury or other antiseptics; as this paste does not entirely harden it is covered by a metal cap so that the pulp is protected from pressure exerted during the introduction of the filling. Sometimes the surface of the pulp is painted with some resinous varnish to which antiseptic substances are added (Witzel). This is for the purpose of preventing any portions of the cement from entering the tissues of the pulp.

[In cases in which the dental pulp is very sensitive to thermal changes, whether before or after filling or during treatment, it is very desirable that it be removed as completely as possible from this source of injury. In fact, in many cases recovery depends more upon this than anything else that may be done, and without it our best efforts may be futile. To some extent this may be done by the patient, if properly directed in regard to the avoidance of draughts of cold air and the use of warm or cold drinks or food. But very many cases occur in which a change of temperature of 4 to 10 degrees will produce intense pain and be the cause of serious injury, if often repeated. In all such, and even in very much less grave cases, I am in the habit of softening a bit of the ordinary trial-plate gutta-percha (the common red), and quickly moulding it over the affected tooth and including a neighboring tooth on either side. This should cover all of the crowns of the teeth and extend onto the gum upon both sides. When it has cooled sufficiently it should be

removed and pressed together very slightly from the sides, so that it will be very tight when replaced, and then hardened in cold water. It may now be trimmed in such shape as to cause the least inconvenience to the patient, and placed in position. The effect of this will be almost complete protection from thermal changes. This should be worn when out in the air, especially if the weather is cold, and in drinking any kind of cold or warm liquids. Also in eating unless the food be of the temperature of the body. At other times it may be left off. The patient should be instructed as to its use. In many cases it will be found best to keep it on continuously for some days or until the sensitiveness has markedly abated.]

On the neck of the tooth there occurs occasionally during entire absence of caries a hyperæsthesia of the dentine. This is evidently the result of hyperæmia of the pulp. This lesion generally extends over a number of teeth at a time, and hence makes patients very uncomfortable.

An excellent remedy for the purpose of allaying such hyperæsthesia I have found in a resinous solution (5 grams of gum sandarac in 10 of alcohol), which the patient uses by painting the sensitive places several times daily. The effect is due to the fact that after the evaporation of the alcohol a small coating of varnish remains on the sensitive place, which answers the purpose of protection against external irritation. The alcohol used in making the solution serves the purpose of deadening the sensibility of the dentine and in course of time entire cure is the result. For this purpose ether is not as good a solvent as alcohol.

When caries exists on the necks of the teeth hyperæmia of the pulp is generally present. Even when the defect is not extensive or deep. It is probable that the pulp in these positions is not far from the exterior, and this is the cause of its complication.

Treatment consists in filling the teeth. If excavation is too painful the surface should be deadened by the use of nitrate of silver, carbolic acid or chloride of zinc. Cocaine is not advisable for this purpose.

If the hyperæmia is the result of an injury to the dentine, it gradually disappears spontaneously, if the injury does not reach near (about 1 mm.) the pulp. The pain can be lessened somewhat by cauterizing the injured surfaces. Fractures in the vicinity of the pulp generally cause pulpitis.

Hyperæmia of the pulp, when occurring after the filling of teeth, is treated by an application of counter-irritating remedies, such as tincture of iodine.

Inflammation of the Pulp.

The most frequent cause of pulpitis is the encroachment of caries. This removes the natural covering of dentine that normally protects that soft tissue. Chemical, thermal, and mechanical irritation can reach the pulp now as direct as in the case of a burn, in which the epidermis is lost and the papillæ of the skin are directly attacked. In addition, within the carious cavity there is a septic irritation that in common with other irritation certainly leads to an inflammation of the pulp.

Two stages of inflammation are recognized, a partial, or superficial, and a total. The former occurs if caries has slowly penetrated the dentine, and when the pulp has lost only a slight extent of its covering of dentine; and the latter, if the carious process is acute, in which case a large surface of the pulp is robbed of its protection at once. Most frequently, however, total inflammation is the result of partial. If an inflamed pulp is examined immediately after the extraction of a tooth, it is generally found very pale, because its vessels have discharged their contents, and almost like cartilage, (the pulps of teeth extracted from the cadaver have generally more of a red color). If a superficially inflamed pulp of a tooth extracted from the living body, is examined, it will be found to possess hæmorrhagic infarctions and infiltrations of pus upon its surface. In total inflammation pus will be found in the deeper layers as well as in those parts of the pulp that are in the root, while the surface is more or less destroyed by ulceration. Microscopically examined, in the vicinity of the pus and the hæmorrhagic infarctions, the connective tissue cells are proliferating, the coat of connective tissue surrounding the smaller vessels and the nerve fibres appear clouded with fat globules and cell-nuclei.

Partial inflammation generally leads to total inflammation, and this terminates in entire decomposition or gangrene. In rarer cases the inflammation becomes chronic. The connective tissue elements then destroy the nerves and vessels to such an extent, that a chronically inflamed pulp is not very painful when mechanically irritated; nevertheless, continued maceration and septic infection of a pulp

suffering with chronic inflammation leads to acute exacerbations, and to neuralgic affections of the trigeminus. Chronic inflammation sometimes results in the formation of polypus.

It is often necessary for the practicing physician to be able to diagnosticate pulpitis. A physician is impotent during an attack of tooth-ache if he is unable to diagnosticate pulpitis from an inflammation of the root membrane. It frequently occurs that neuralgia of the infra-orbital, supra-orbital, auriculo-temporal, tympanic-plexus, etc., is the result of the inflammation of a pulp in some diseased tooth. By a proper diagnosis in these points, the physician may be able to save the patient months and even years of pain. It frequently occurs that a patient will designate an entirely different tooth as the one causing the pain, than the tooth that is the real cause. This is generally the case when the tooth affected by pulpitis is far back in the mouth, and the opening to its cavity is hidden by an adjoining tooth, and when the patient has long known of a cavity in some other tooth. The latter, as a general rule, is pointed out as the one causing the pain, though it is not. The physician, who is sometimes expected to extract the tooth, must be in a position not to be deceived in this particular.

The experienced observer is prepared, even at a superficial examination in most cases presented, to diagnosticate between inflammation of the pulp and inflammation of the periosteum. The symptoms are: intermittent pain, which generally occurs in the earlier stages after partaking of cold fluids, by drawing air into the tooth, from sweet and sour food, and finally, when any hard substance becomes lodged in the cavity, and pressure is brought upon it during mastication; generally these pains are most severe at night, and cause loss of sleep. During examination it should be remembered that a tooth affected by inflammation of the pulp is carious, but the enamel (if any still exist) has its normal, live appearance, its gloss and bright color, unless there is decayed dentine beneath it, which would give it a dark appearance.

A slight touch to the tooth with the finger, will reveal by the action of the patient whether it is painful. As a general rule, if the tooth is painful to the touch there is inflammation of the root membrane and not of the pulp. This is true, however, only when the contact is with enamel which is intact. If pressure is made on the soft débris within the cavity, it is communicated to the pulp and

causes pain, hence in this case it is the pulp and not the periosteum that is involved.

A reliable way of determining the presence of inflammation of the pulp is the application of cold water to the suspected tooth. When upper teeth are examined, precaution should be taken not to permit the water to touch the lower teeth where it may eventually run into defects that might cause pain. One may be led into error in believing a patient shrank when the water touched the upper tooth, while in reality it was in the lower tooth that pain was felt. The patient's head should be inclined according to circumstances into such a position as to prevent this. The same precaution should be taken if in the same jaw there are several teeth that may be suspected as being the source of pain.

[A better plan consists in placing the rubber dam over the suspected tooth and then applying cold water. In this way a mistake becomes almost impossible. Generally the dam may be applied to tooth after tooth in succession with rapidity and but little trouble. The impossibility that the cold water shall go where it is not wanted renders the diagnosis much more satisfactory, especially in cases that are in some degree difficult. It often happens that much may be done by confining the cold water by the use of napkins, especially by covering the suspected tooth while the cold water is thrown over the others generally.]

When inflammation of the pulp is superficial, the application of cold water to a tooth is a reliable method of diagnosis. If the outer surface of the pulp has been destroyed by ulceration, it is not so sensitive to cold. Upon inquiring of the patient it will be learned that the tooth may have pained at various intervals for four, five, and even six weeks, and that the pain is most severe at night. If the tooth is moistened with hot water instead of cold during this stage, pain will be produced. When no response is given with all of these modes of examination there remains nothing to do but to cleanse the carious cavity with an excavator, a procedure that is comparatively painless, as the superficial parts of the pulp are disintegrated. Thus it will be determined whether there are any living portions of the pulp in the tooth. If such is not the case the question arises whether there is any inflammation of the pulp. When the symptoms indicate the presence of inflammation, all the teeth on the side of the face in question should be carefully examined.

Occasionally a tooth will be found that has a bluish tinge, and whose side is transparent, thus most likely the cause of the evil. Sometimes one or another of the teeth will be found sensitive to cold water, and yet there is no carious place upon its superficial surface. In these cases the pain is frequently caused by hyperæsthesia of the dentine near the neck of the tooth, which, when touched by the finger-nail, is found to be very painful. In other cases smaller or larger pulp nodules are the cause of the pain.

Such dentine formations are accidentally found in carious teeth very frequently, though they have never given any symptoms of their presence. Cases are on record in which these formations are said to have caused the most excruciating neuralgic pains. Occasionally almost the entire pulp is filled with such nodules, leaving but a very small fibre of pulp tissue, and this is capable of causing the most intense pain.

One of the most remarkable symptoms of inflammation of the pulp is the radiation of pain. When a patient complains of racking pains on the entire side it may be taken for granted that there is a tooth suffering from inflammation of the pulp from which these pains originate. It occurs that the patient designates a tooth in the upper jaw from whence the pain originates, but it may be discovered that its origin is from a lower tooth, whose pulp is inflamed, and *vice versa*. Radiation from the right to the left side, or from the left to the right, I have never observed, but such cases have been reported.

As has been stated, in a large majority of cases, dental caries is the cause of inflammation of the pulp. Fracture is seldom the cause; other causes are still less frequent. I have had opportunity to observe a very interesting case,* in which I found inflammation originating from a deposit of granular calculus with which the root of the molar in question was coated as far up as the dental foramen. In this case that portion of the pulp within the root was the part to be first affected. The pulp nearest the masticating surface of the tooth was perfectly normal, while that portion in the root covered by the calculus was suppurating. It is not to be doubted that inflammation was occasioned by the septic disintegration of the contents of the dentinal canals, and that the latter was caused by the destruction of the periosteum.

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*Parreidt, *Pulpitis in einem nicht cariösen Zahne.* (*Viertelj. f. Zahnh.* 1880, Number 1.)

A peculiarity of the pulp in very young temporary teeth is worthy of notice; sometimes as early as one year after their eruption, that is, in children from one and a half to two years in age, the pulp may be destroyed by acute caries. This occurs especially on the upper incisors of poorly nourished children. The crowns of these teeth are found to be softened like cartilage, but without change of form. Lack of friction of the teeth does not cause a wearing away of the softened portions. The child often suffers from severe pain, but neither parents nor physician can determine whence it arises. By making a careful examination the physician can determine that if the softened portions of these teeth are touched, causing pressure of the cartilage against the pulp, the child cries. Gradually the pains subside, the cartilage loosens, drops off, and the pulp is bare. It is at this time very tender, but gradually becomes chronically inflamed and partially hypertrophied. The nerves undergo atrophy and the large pulp at last becomes painless. At the age mentioned, the pulp still retains the character of the dentine organ; hence in but partially grown roots whose walls are not thicker than those of a large goose quill, it has a thickness of several millimetres.

Occasionally inflammation of the pulp follows filling. Diagnosis in these cases is not difficult. All the teeth on the side in question should be subjected to a thorough examination, but especially the neighbors of the filled tooth should be searched for caries in order to determine with certainty that the pain that the patient may locate in the filled tooth, does not come from some of the other teeth. If this is determined with certainty, and the filled tooth is sensitive to cold water, it is most probable that that is the tooth suffering from inflammation of the pulp.

In the treatment of inflammation it is especially essential to know the exact stage of the disease. When the case is one of superficial inflammation, the pulp may be restored to health. For this purpose, anything that possibly leads to inflammation should be allayed. The first step is the removal of the carious masses under antiseptic precautions, and to fill the cavity under the same precautions as fully described when speaking of hyperæmia of the pulp. As a general rule, the superficially inflamed pulp is restored to a normal condition by simply removing, under antiseptic precautions, all substances that may cause mechanical irritation. Any exudate

that may be still produced is absorbed and disinfected by the porous and antiseptic plaster-of-paris. In other respects the inflammation is healed by resolution.

Instead of carbolic acid and plaster-of-paris a preparation consisting of infusorial earth and iodoform, which is made plastic with vaseline, may be used. The infusorial earth readily absorbs the exudate, and the iodoform is a powerful disinfectant.

It is proper practice in the treatment of these cases, whenever such a thing is possible, to use the smallest amount of metal or very hard filling, but to leave as much as possible of the porous antiseptic mass. The advantage is, that in case of pain, if it should be necessary to remove the filling there will be less inconvenience and a minimum of pain to the patient. Pain may occur when the inflammation does not entirely subside, or when the symptoms previous to the filling did not indicate that the inflammation of the pulp had advanced to such a degree that there were pus-infiltrations in the deeper parts of the pulp.

In any case in which inflammation of the pulp is thus treated the tooth should be examined after a certain lapse of time (from three to six months after filling), even if no pain has resulted; this is for the purpose of determining whether the filling may be considered a permanent one. If such is not the case the tooth should be re-filled, and in doing this precautions must be taken not to expose or injure the pulp, but to allow the capping to remain undisturbed.

When general inflammation has resulted, or even if partial inflammation has affected the greater part of the pulp, there is no reasonable probability that it can be preserved. In more favorable cases of diffused partial inflammation, healing would require a longer time during which the patient would be obliged to suffer pain. It is generally preferred in these cases to devitalize and extirpate the pulp. For this purpose the most reliable agent is arsenious acid, to which some carbolic acid has been added, but it is not recommended to place this in the decayed tooth without further precautions. If this were to be done the septic contents of the cavity would be pressed against the pulp, and cause severe pain. It is further necessary (and this statement holds good when any medicine is placed in a carious cavity) to cleanse the cavity from all septic matter. The operation is not painful, especially in cases

of total inflammation of the pulp, if it be done skillfully. Upon further excavation the pulp will be plainly observed as a dark red spot, which can be scarified with the excavator. Sometimes on opening the pulp-chamber pus will exude from it.

The agent for the devitalization of the pulp should be placed directly on the exposed surface of it. According to an old formula the following is recommended:

℞

Arsenious acid,
Acetate morphia, āā
Creasote q. s. f. p. moll.

Of this a small amount is taken on a pellet of cotton the size of a pin-head, and is placed in the tooth.

It should be observed that the arsenious acid does not dissolve in the creasote, but is only held in suspension. While standing, the arsenious acid is deposited in the bottom of the flask, and the cotton pellet must be passed through it in order to reach it, or the mass should be stirred before using.

In order that the quantity of the adhering mass may be better determined, I am in the habit of using a small piece of punk instead of the cotton; on this the arsenic can be seen readily. I replace the creosote by carbolic acid, because it tastes less unpleasant and is of a more agreeable odor; I add it according to requirements.

Arsenious acid in a dry state is not to be employed or recommended; while introducing it particles may be dropped in the mouth; but in addition to this, the carbolic acid seems to furnish material aid to the effect of the arsenious acid.

Instead of morphine, for a number of years I have used iodoform and am confident that the latter is more efficient in decreasing the pain than the former. Hence I have not found it necessary to mix the arsenious acid with cocaine, for the purpose of allaying pain during devitalization, as has been recommended recently. My formula is:

℞

Arsenious acid,
Pulv. Iodoform, pure alcohol sat.
Acid. carbolic, pure āā

The amount necessary to devitalize a pulp is a quantity ranging from 0.002 to 0.003 of a gramme (2 to 3 milligrams, gr. $\frac{1}{37}$–$\frac{1}{50}$). It should never be more than 0.006 (gr. $\frac{1}{25}$).

In order to retain the paste in its proper position it should be sealed into the cavity. The most convenient agent for this purpose is a pellet of cotton moistened in a solution of gum mastic or sandarac, or a mixture of both in alcohol or ether, placed in the cavity, and pressed into position.

[Another plan of making the application is to cut a piece of writing paper that will pass easily into the cavity, and much more than cover the exposed point of the pulp; a little of the arsenical paste is placed on the centre of this, carried into the cavity with the pliers, and pressed gently into place. It should be observed whether or not any of the paste has been pressed out beyond the margins of the paper; and if any appears it should be cautiously removed with a bit of punk or an excavator. There should not be enough fluid to cause the paste to run much, but in no case should it be too stiff. When all is nicely done the cavity may be stopped as recommended above, or, what is perhaps safer, it may be filled with ordinary trial-plate gutta-percha. However the filling be made it should be done very carefully, so that the cavity shall be water-tight in order that there shall be no leakage of the arsenic about the cervical margins of proximal cavities, for in this case serious injury may be done to the gingivæ and margins of the alveolar processes. Some time ago I observed a case in which three molars of the upper jaw (including the third molar) with their alveoli were exfoliated from this cause. In no case should such an application be made without having first adjusted the rubber-dam.]

This application frequently relieves pain instantly. Occasionally within a few minutes the entire pain has disappeared. It is best, however, to inform the patient that pain may continue as much as half an hour. The application should remain at least six hours. Generally it is not removed until the following day, and the pulp, which is now not sensitive, or only slightly so, may be removed, and the tooth filled.

The body of the pulp is removed by enlarging the entrance into the pulp-cavity with an excavator, and bringing out the devitalized portions with a sharp spoon excavator. Sometimes the dental engine can be used for this purpose. The entrance is readily enlarged, and the body of the pulp severed with a bur.

To remove the remnants of pulp-tissue from the root canals, barbed broaches are employed, or a fine instrument that may be

used with the dental engine. Frequently portions of tooth-substances must be removed in order to properly reach and be able to operate within the root-canals. Where these are small they must be enlarged with small burs, with which the remnants of the pulp are at the same time removed. Sometimes, with all possible care, it is impossible to remove the pulp entirely up to the dental foramen. The prognosis in these cases is generally unfavorable, because the contents of the root-canals may become gangrenous or maintain an inflammatory condition, which readily leads to inflammation of the root membrane.

In order to prevent this, it will be necessary to fill the root-canals as far as the pulp has been removed with some substance designed to protect the remaining parts and prevent their undergoing septic decomposition; such substances are iodoform, bichloride of mercury, etc. The pulp cavity is filled with a plastic, and the carious cavity with a dense filling. In this manner the remaining portions of the pulp become mummified. But this treatment is not entirely sure to prevent future pericementitis. At any rate, occasionally we find cases of teeth affected by acute pericementitis, in whose canals there is not the slightest odor present, in which therefore no septic decomposition has taken place. It is most probable that the accompanying stasis in the root membrane, that must follow the destruction of the pulp, is the predisposing agent of pericementitis. As a general rule, ninety-five per cent. of the cases of devitalization of the pulp, followed by proper antiseptic treatment, and in whose treatment care has been exercised, should be successful.

These results are sufficient to justify the adoption of this course of treatment in partial inflammation instead of endeavoring to retain the life of a pulp so situated that the cavity is difficult of access, and consequently the pulp could not be treated with proper care.



FIGS. 16 AND 17.
Enamel Chisel and Excavators.

The general practitioner in small cities, or in the country, who does not practice special dentistry, is in a position to relieve patients who may be suffering from inflammation of the pulp; he can readily and certainly perform a valuable service by allaying pain. It is only

necessary to have an enamel chisel and four excavators (see Figs. 15, 16 and 17) to remove the débris from the cavity, and to place therein a few milligrams of arsenious acid.

For the best interests of the mouth and the preservation of the tooth, the patient should be recommended to have it attended to and filled by a dentist, at the earliest opportunity.

The effect of arsenious acid upon the pulp is almost infallible. It fails only when the paste has not been applied in the right place, or when it has been moved, or if pulp nodules exist in the pulp chamber, which make it impossible for the undissolved arsenious acid to come in actual contact with the pulp.

When a tooth is so badly decayed that it is not worth the filling, extraction should be preferred to devitalizing the pulp. It is better for the patient not to have the tooth than to keep it while in a decaying condition.

In every cavity septic masses are being continually developed, which mingle with the food during mastication, and thus give rise to disturbances of digestion. A tooth whose pulp is putrefying produces much more decomposition-ferment than one in which caries has not yet reached the pulp chamber. The destruction of the pulp (a common term for devitalization) is an entirely useless operation when done only for the purpose of allaying the pain, and not as a preparatory step to filling.

Pain in filled teeth from inflammation of the pulp occurs in those cases in which the cavity extends near the pulp, especially if soft dentine remain over the pulp. The pain is first noticeable when the tooth comes in contact with cold water, and on the inhalation of air through the mouth. Gradually, contact with hot food becomes painful, and finally there are but few degrees of temperature (from $+ 20^{\circ}$ to $+ 35^{\circ}$ C) that do not cause pain. There is spontaneous pain at night, and neuralgia of the trigeminal branches also follows.

Treatment is at first confined to the use of tincture of iodine; this is applied to the gums of the affected tooth, and over the adjoining ones, with the object of allaying hyperæmia within the pulp, by a counter irritation causing hyperæmia in the gums. If neuralgia results, and sensitiveness during eating and drinking, and if, finally, pain comes on at night, a cure cannot be expected; the case will terminate in pericementitis. The filling should be removed, the pulp devitalized and removed, and the tooth re-filled.

Tumors and Atrophy of the Pulp.

Secondary Dentine.—In the development of dentine there is a continuous building up, at the periphery of the dentine germ. These dentine formations do not cease, as those of the enamel, before the eruption of the tooth, but are very active during the first two and even three years after eruption. In the succeeding three to six years, the formation of dentine is much slower, and at the twenty-fourth year of age it seems to have reached a stand-still. After this there are only a few positions of the surface of the pulp where dentine production may take place, and these correspond to the positions of abrasion on the outer surface of the tooth.

It seems as though the odontoblasts on the inner wall of the dentine are quickened into activity by the irritation that affects the periphery of the fibres (Tomes' Fibres). In those teeth that have abraded defects on their necks in addition to those on the masticating surfaces, there are secondary dentine formations in the points of the pulp and on its sides, corresponding to the position of the wedge-shaped defects. In the case mentioned on page 45, in which the enamel was entirely removed, as well as the greater part of the dentine on the labial surface, I found the pulp entirely dentified. Opposite chronically carious places secondary dentine will be deposited, occasionally to such an extent that the pulp is reduced to a few barely visible fibres.

Aside from secondary dentine we sometimes find smaller or larger formations of dentine nodules (dentinoids, internal odontomes and pulp-stones), sometimes attached to the walls, and sometimes perfectly free. In microscopic sections they show more or less regular dentine-canals running from the centre to the periphery, and generally possessing that transparency that is found in the roots of the senile, and in the vicinity of carious defects. In the centre, there is frequently a small undentified space, the remainder of the pulp from which the secondary dentine was formed.

The pulp-stones are present in large numbers in some teeth, as many as twenty and more. Their size ranges from the smallest particles to the size of a grain of rice. Generally they do not give rise to any symptoms, and are accidentally found when a pulp has been destroyed in consequence of inflammation. But in occasional cases they lead to serious neuralgic pains.

The diagnosis cannot be established always with certainty. The patients generally suffer with infra-orbital neuralgia, and complain at the same time of tooth-ache, calling attention to the fact that paroxysms of pain begin in one or more of certain teeth, and that they then spread over the entire face. If in these cases no decayed teeth are found, it may be presumed that the pain is caused by an odontinoid formation on one of the pulps. To ascertain the proper tooth it is necessary to test all the teeth on that side with a current of cold water, examine each tooth by percussion, and to let each one, separately, bite on some hard substance. If the patient experiences the slightest abnormal feeling in any of the teeth it may be taken for granted that in that tooth there are pulp-stones.

Formerly the treatment was confined to extraction of these teeth. Experience proved, however, that pain is not confined to a single tooth, and that after a few weeks or months of comfort the same symptoms appeared in an adjoining tooth. This was also extracted, and so on a number of others. Recently attempts have been made to allay the irritation of the pulp from which the neuralgia originates, by drilling an opening near the neck of the gum with the aid of the dental engine, and then devitalizing the pulp with arsenious acid. This course is successful if the pulp-stones are not so large as to prevent an extensive contact of the arsenious acid with the pulp.

[After a critical examination of a large number of cases of hard formations in the dental pulp I have become convinced that pain from this cause alone is very rare indeed. It is certain, however, that these bodies give much trouble when connected with other diseases of the teeth that affect the pulp, and precipitate a condition of fatal hyperæmia or infarction when otherwise there would be serious difficulty. The general opinion that caries causes new dentinal formations at the pulpal ends of the dentinal fibrils affected, is maintained by direct examination only in a minority of cases. In others the secondary formations are general through the pulp; not only this, but general in the teeth of that person, whether affected by caries or not. In mechanical abrasion of the teeth the secondary formation includes the entire walls of the pulp chamber, as a rule, and is as pronounced upon that part most distant from the abrasion, as that nearest it. Furthermore, those teeth that from their position, or through loss of an antagonist, have escaped abrasion, have the

same formation of secondary dentine as the others that have been abraded. From these facts we must conclude that while this deposit is undoubtedly a result of the abrasion, the effect is general rather than local.

Pulp nodules occur in the best of teeth, in those in which there has been neither abrasion or decay. The formation of these bodies is evidently dependent upon some other cause that is as yet unknown. Local formations of secondary dentine proper, such as are attached to the walls of the pulp-chamber and have true dentinal canals, seem to be caused by the irritation of caries or some local injury to the dentinal fibrils. In case it is necessary to devitalize a pulp for the cure of a neuralgic affection that has been traced to a particular tooth, supposed to contain hard formations, the tooth should be bored into in the best position and direction for reaching into the root canals, and the effort made to find a way, through the hard formations that may be found, to the apex. This is the more practicable since it is found that in very many of the cases in which the pulp chamber is occluded with these formations, the root-canals remain open, and are readily entered after passing the obstructions that occur at the point where they join the bulb of the pulp.]

Hypertrophy of the pulp is the result of caries. It is preceded by chronic inflammation. Since in hypertrophic tissues the nerves do not retain the same degree of growth with the connective tissue parts, the hypertrophied pulp, or pulp-polypus is not so painful by far as the normal or acutely inflamed portion. Hence such polypi are sometimes permitted to remain months and even years.

Treatment consists either in the extraction of this particular tooth or in the extirpation of the polypus with a sharp spoon-shaped excavator. The remainder of the pulp should be then devitalized and the root-canals treated in the same manner as in cases of total inflammation of the pulp.

Gangrene of the pulp generally results immediately after acute inflammation; as the result of an over-supply of blood in the arteries the veins are compressed at the dental foramen, and hence, because of this stasis, the circulation is almost wholly and sometimes entirely interrupted. By the presence of decay and bacteria the dying pulp-tissue undergoes a septic decomposition causing a penetrating, disagreeable odor. When the septic influence becomes communicated to the periosteum it results in inflammation of that

membrane. Occasionally small particles of the pulp retain life and cause intermittent neuralgic pains for a period of days and months.

The diagnosis of gangrene is not difficult. An excavator is introduced carefully into the pulp chamber; if this examination is not painful the pulp is entirely disintegrated. If there is some pain there must be living tissue present.

[Not infrequently the passing of an instrument into the débris contained in a pulp-chamber, in which the pulp is wholly dead and decomposed, will cause the fluid contents to press against the tissues at the apex of the root through the apical foramen and cause pain, especially if these tissues are already in a state of irritation. Care is required not to mistake this for a portion of the living pulp.]

The instrument used in this examination will receive the odor of the contents of the cavity.

Treatment consists in the removal of all gangrenous remnants of the pulp, and in the perfect disinfection of the root canals. In order to reach the most distant portions of the root canals, it is often necessary to enlarge them with the dental engine. The canals are then injected with a solution of bichloride of mercury and a pellet of cotton containing some powerful antiseptic is introduced. I use carbolic acid and iodoform. A few hairs of cotton are dipped in carbolic acid, and then in iodoform powder, and the mass introduced in the root-canals with a very fine broach, but without exerting pressure. For the protection of these remedies, and to prevent them from being washed out of the cavity, a pellet of cotton dipped in some resinous solution is placed in the carious cavity. This dressing is removed on the following day; if there is no disagreeable odor on the cotton the tooth may be filled immediately. Otherwise these disinfecting dressings should be repeated until all the unpleasant odor has disappeared. In filling these teeth, the roots are filled with oxychloride of zinc. Although this itself is an antiseptic, there is generally added an antiseptic substance, such as iodoform. Recently this has been brought into a convenient form for use by mixing it with cacao butter (Schneider's iodoform rods). In filling the roots, care should be taken that no air is pressed through the dental foramen. The filling material should be introduced without making pressure, gently and slowly, in such a way that the air can escape alongside of the instrument and the material.

Soft gangrene of the pulp occurs in sound teeth. It is caused

by inflammation in the vicinity of the tooth, which leads to such a serious compression of its vessels that circulation within the pulp cannot continue. Since atmospheric ferments have no access to the pulp chamber, the enamel and dentine being impermeable to air, the result in these teeth, instead of being gangrene of decomposition, is simply soft gangrene. I have seen typhoid fever and trauma followed by this class of cases. (See *Zahnärztl. Mittheilungen*, page 111, and *Monatsschr. f. Zahnh.* 1883, Band 12.) [According to recent observations, it is possible, in case there is a focus of suppuration in any portion of the body, for the micro-organisms to pass from this into the blood, and thence they may find lodgment in any part of the body, when the conditions happen to be suitable for their development. Hence it occurs that pus may form in a pulp that has not been exposed, and alveolar abscess may result.]

The diagnosis of soft gangrene is generally not easy, since the pulp is not accessible, and no discoloration of the tooth exists. In some cases there is chronic inflammation of the root membrane, but in other cases even this is wanting. If such a tooth has a fistula, or is affected by chronic pericementitis, it should be extracted, but if it gives no trouble, it may be generally permitted to remain.

Calcification of the pulp is sometimes found in carious teeth, but it occurs just as frequently in those that are not carious. From a therapeutic standpoint it is important only in so far as it lightens the operation of filling, as is the case when operating near a non-sensitive calcified pulp instead of a sensitive uncalcified one.

The net-like atrophy that Wedl (Pathology of the Teeth, page 186) describes, has little practical importance. If in filling, such a pulp is exposed, it must be devitalized and the root-canals must be filled.

CHAPTER V.

DISEASES OF THE PERIOSTEUM.

Acute Inflammation (Periostitis Dentalis), Apical Pericementitis.

Apical pericementitis is in most cases consequent upon inflammation and gangrene of the pulp, and next to pulpitis the most frequent cause of tooth-ache.

If apical pericementitis simply follows pulpitis it is most probable that the inflammation was continued from the pulp to the periosteum, as the vessels of both tissues are from a common branch, and as the connective tissue that enters with the vessels through the dental foramen into the pulp chamber is immediately connected with the periosteum at the apex of the root. An entire septic decomposition of the pulp is more frequently the cause of periostitis. In these cases the cause of inflammation is the septic fluid that finds its way into the alveolus from the root-canal, as a result of capillary attraction and a pressure that may be exerted by the formation of the gases of decomposition.

At the beginning there is hyperæmia of the periosteum, especially near the apex of the root; then follows transudation from the vessels, and a discharge of white blood-corpuscles followed by proliferation of the connective-tissue cells. The root-membrane becomes cloudy in spots. Later, this cloudiness increases, and spreads over the entire thickened root-membrane. Finally pus is formed in various places. Occasionally the process of inflammation is confined to the apex of the root; in other cases it spreads and becomes diffused over the entire root-membrane.

Symptoms of apical pericementitis.—At first the patient experiences a feeling as if the tooth was raised in its socket, and was "nappy," which leads him unconsciously to bite on the tooth in order to push it into its place, and the abnormal feeling momentarily disappears. In addition, the tooth feels somewhat loose, which leads the patient unintentionally to move it. These sensations are the result of hyperæmia, a congestion of the vessels of the root-mem-

brane. Pressure upon the tooth compresses these vessels, and the hyperæmia is momentarily relieved.

But gradually this hyperæmic condition leads to changes that do not subside so readily. The parenchyma of the root-membrane swells, and the connective-tissue cells proliferate, serum transudes from the smallest vessels, and colorless blood-corpuscles escape. Thus the tooth is raised still further from the alveolus, and becomes loosened. Formerly the patient felt only as if the tooth was loose and longer, but now even the physician can readily ascertain it. In addition, the tooth is sensitive to pressure, and even contact with the tongue is painful.

The inflammation often spreads rapidly, so that a swelling of the periosteum on the outer surface of the alveolar process, a periostitis alveolaris, can be diagnosticated. In other cases the inflammation is confined for a number of days to the root-membrane, and neither is the alveolar periosteum attacked, nor is there a return to the normal. Sometimes the patient complains that the inflamed tooth is sensitive to cold water. In so doing a symptom is mentioned that existed weeks or months ago, at a time when the pulp of the tooth now suffering from apical pericementitis was inflamed; or, a tooth suffering from pulpitis may be found on the same side of the mouth, and the patient confounds the pain in this tooth with that suffering with periostitis. In other cases, again, the last stages of total inflammation, or gangrenous decomposition of the pulp, accompanied by a slight periosteal inflammation may be diagnosticated, if there is pain on percussion with the handle of an excavator, while there may be no pain to a gentle touch. These are the cases in which inflammation was simply continued from the pulp to the periosteum, and in which the slight periostitis may be considered simply as a symptom of total pulpitis or gangrenous decomposition of the pulp. This slight periosteal inflammation disappears in these cases if the pulp is removed or devitalized with arsenious acid.

Periostitis of the roots from which the crowns are lost is not apparent to the patient by the feeling of length or looseness, nor can the physician apply percussion to the roots so readily. The earlier stages of periostitis of the roots can be recognized only by strong pressure, which should be applied with the excavator on a solid portion of the root. Should the patient wince on the applica-

tion of such pressure, when similar application upon other roots or teeth is not noticed, it may be considered that periostitis of the painful root exists. Care must be taken not to break through a weak portion of the root and injure the gums. The instrument should not be permitted to slip off, nor should the pressure be applied briskly into the root-canal, since in that case septic substances may be compressed, driven through the dental foramen into the alveolus, and thus the examination might result in an inflammation.

In the treatment of acute apical pericementitis the removal of the cause should be the first step. Until a few years ago the retention of teeth whose periosteum had been inflamed was considered impossible; to-day it is as easy as the saving of teeth with pulps. The treatment is simply local. With caution not to cause the patient pain, the softened parts are removed from the cavity as far as to the opening of the pulp chamber. It is good practice to paint the gums with tincture of iodine, which treatment relieves the congestion of the root membrane. If pus has already formed, tincture of iodine is of no service. In these cases, on opening the pulp-chamber a drop of pus immediately escapes, and as a result the pain is relieved in a few minutes. Even if no pus escapes, relief from pain may be anticipated, as the gases of decomposition are allowed to escape from the pulp-chamber, thus relieving the pressure from the direction of the apex of the root. Septic fluids are led in the opposite direction, away from the dental foramen. If a pulp is found in a connected but gangrenous condition it is best to remove it immediately. Relief from pain is then certain.

Further treatment can be continued on the following day, at which time all carious and septic substances may be removed from the tooth without causing pain. Should the tooth still be painful, the cleansing of the root-canal is nevertheless proceeded with, but the cavity is permitted to remain open for several days, that all exudation from the periosteum may escape before the tooth is filled. The patient is advised to rinse the mouth frequently with a solution of permanganate of potash, and at the same time to suck the open cavity. Patients have the instinctive feeling that in order to relieve tooth-ache something must be placed in the carious cavity. In cases of periostitis the inflammation would be increased by such procedure: it is best, therefore, to explain this to the patient, and to express a

positive desire that the cavity should be left open for several days. If the pain has entirely disappeared, and the root-canals are thoroughly cleansed, they are then disinfected. [Before the canals are cleaned and disinfected, the rubber dam should be adjusted to the tooth to prevent the possibility of its again being flooded with saliva. For since the saliva always contains micro-organisms its entrance into the cavity is likely to defeat the efforts of the operator. When once disinfected, the cavity should be thoroughly sealed (moisture-tight) with some temporary stopping in order that an aseptic condition may be maintained, and in no case should this be removed at a subsequent sitting until the rubber dam is readjusted and the parts included within it disinfected. If the formation of pus should continue, and cause pain, which is but rarely the case, the temporary stopping should be removed and the pus discharged as often as necessary; but to leave the cavity open is to re-infect the parts and continue the difficulty.] For this purpose I use a few hairs of cotton, moistened with carbolic acid and then dipped in finely powdered iodoform, in each root-canal, and close the cavity with a pellet of cotton dipped in sandarac varnish. If there is no pain for several days the canals are filled and the cavity hermetically sealed—that is, permanently filled. Sometimes the sealing with sandarac varnish is followed by pain. In those cases the tooth must be permitted to remain open for several days.

When filled teeth are affected by periostitis the gases of decomposition are furnished with an outlet by drilling an opening about 2 mm. in diameter, at the neck of the tooth, and leading into the pulp-chamber. If the root-canals have been hermetically sealed no relief will follow such treatment. But if they are only loosely filled, the pain is generally diminished or entirely allayed. The vent-hole is in great part covered by the gums, and caries seldom results. Hence it may be permitted to remain open without question. If it is desirable to close it, it can be done only after a thorough cleansing of the pulp-chamber, and then at first only temporarily with some such substance as gutta-percha. If the filling is not perfect it is best to remove it, that the treatment of the root-canals may be made radically antiseptic. This must be done also if the filling is perfect, and the trepanaion does not give the desired result. The root-canals must be entirely cleaned and emptied before any relief can be expected.

[This ancient plan of drilling a vent-hole to relieve a tooth from the pressure of gases forming within the pulp-chamber should be consigned to past history. It is better in each case to do the drilling for immediate relief in the proper position for opening, and properly disinfecting the pulp-chamber, which may be perfectly carried out so soon as the abatement of the immediate pain and soreness will allow.]

If the patient does not care for the retention of such an inflamed tooth, as is often the case in practice among paupers, and especially if the tooth in question (perhaps in consequence of the loss of its antagonist) cannot be used in mastication, but is not near the anterior part of the mouth, so that its loss should interfere with speech, its extraction will be justified.

Thus far only acute periostitis has been considered, such as has originated from septic influences within the pulp chamber. There are many other causes that lead to periostitis, such as the action of phosphorus, mercury, etc.; in these cases the inflammation of the root-membrane is simply part of the symptoms affecting the entire organism during such disease, and need not be considered here. It is only necessary here to mention traumatic periostitis. This results from biting on some hard substance, especially unexpectedly, as for instance when a pebble or stone may chance to be in bread, or a hard splinter of bone in meat. These cases do not result in formation of pus although the pain, in a slight degree, may continue for weeks. In older persons traumatic inflammation occurs more frequently than in young persons, and in those cases it may lead to loss of the tooth. Periostitis of the teeth frequently occurs in old people under such circumstances as the following: Several teeth may be missing, while those remaining project somewhat from their alveoli, in consequence of atrophy, and at the same time lean over into the gaps of the missing teeth; and during mastication these partly loosened teeth are struck on the edges instead of on the masticating surface. The periosteum degenerates and becomes hypertrophied. If in some instance the border of such a tooth is unexpectedly struck very hard in biting, it may lead to a severe inflammation, and the patient may be anxious to rid himself of the offending member. In other cases, especially in those of a milder form, rest only is required, until the tooth is again painless. Tincture of iodine painted on the gums will hasten recovery.

Arkövy (Diagnosis of Dental Diseases) mentions a periostitis marginalis. This occurs occasionally in those teeth in which the roots are lifted out to some extent, or rather from which the gum and the alveolar process have been removed by atrophy, and thus the root is laid bare. These bare portions of the root are very sensitive, just as in hyperæsthesia of the dentine. The treatment is the same as that required for the latter affection—coating the sensitive surfaces with an alcoholic solution of sandarac two or three times daily. [The application of eucalyptol is followed with good results in most cases of this nature.]

Chronic Apical Pericementitis.

Chronic inflammation occasionally occurs in teeth that have been filled, and whose pulps have been destroyed or dead; it also affects carious teeth whose pulps have died; and, further, apparently sound teeth that have frequently suffered from trauma (isolated teeth occupying irregular positions). Most frequently those roots are affected by chronic apical pericementitis whose crowns are entirely decayed away.

The root-membrane of chronically inflamed roots is very much thickened, especially near the apex. The hypertrophied tissue becomes partly fatty. At the apex of the root the fibrous tissue is generally not thicker than the size of a pea. In the centre of the masses of connective-tissue occasionally a cheesy decomposition or formation is found (pus-sac). Baume* considers the connective-tissue membrane as an attempt of nature to protect the bone from infection through the dental foramen. The pain during chronic inflammation of the root membrane is hardly worth mentioning. If the tooth still has its crown, the only information that may be obtained from the patient is that on percussion, or when biting on a hard substance, or upon pressure with an excavator, the tooth in such chronically inflamed condition "feels different" from the others. If the roots only are present the presence of chronic periostitis can be determined only by their looseness. The looseness can be established by placing the excavator with its edge firmly on some portion of the root and then exerting lateral movement. Occasion-

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* *Lehrbuch der Zahnheilkunde.* Second edition.

ally a slight enlargement of the alveolus opposite the apex of the root can be felt; this is consequent on some previous alveolar-periostitis, which may have been communicated to it from the periosteum of the tooth.

Sub-acute and acute exacerbations frequently occur in teeth whose periosteum is chronically inflamed. In acute stages the inflammation is determined in the same way as acute dental periostitis. Sub-acute exacerbation is not determined so readily, for sometimes the patient does not seek relief until it has disappeared. In most of these cases only remnants of roots are present. Two hours before the root may have caused pain, while now there is nothing but the marks of chronic inflammation.

Chronic dental periostitis may be improved by a long-continued open and subsequent disinfecting treatment, but entire cure cannot be relied on with any degree of certainty. The changes of the root-membrane are sometimes too extensive, the degeneration of such a high degree that an antiseptic treatment cannot lead to entire restitution. Nor can any other treatment lead to better results, since in consequence of the degeneration of the root-membrane the apex of the root is entirely necrosed. Hence conservative treatment of chronic periostitis is to be undertaken only as an experiment, when the teeth in question are of much value; otherwise extraction is preferable. And this is the only remedy that remains after an attempt to save the tooth has failed. Replantation has been practiced in these cases, after the necrosed portion of the root is resected, and the tooth is carefully filled outside of the mouth. Replantation is successful in a considerable number of cases, and is perfectly justifiable in cases of especially valuable teeth. It is under any circumstances merely an attempt, the same as the antiseptic treatment of such teeth. The attachment of replanted teeth will be discussed at the close of this chapter.

[In the management of chronic apical inflammation of the peridental membrane there are certain principles of pathology that should be clearly grasped by the mind and acted upon. *First*, the tendency of the tissues simply inflamed is to return to the normal condition, and they will do so if there is no direct hindrance. This is true whether pus is being constantly formed and discharged or not. *Second*, when a case presents itself that seems to have assumed a stationary condition of chronicity, with or without the formation

of pus, there is some impediment to restoration constantly present and active. The treatment then consists in finding and removing this impediment to allow a return to health. There are undoubtedly cases in which the apex of the root has assumed such a condition as to constitute an impediment, it having absorbed into its substance such an amount of the poisonous products of decomposition that its mere presence will cause inflammation of any tissue that may be brought in contact with it. Again, the surface of the denuded apex of the root may have received a deposit of serumal calculus, coating it over with jagged prominences which constantly irritate the tissues with which they may be in contact. This may often be observed in teeth which have been extracted. In cases in which the deposit is not readily seen, it can be felt by the finger, giving the impression that the apex of the root is covered by minute points like a bur. Critical examination will show minute crystals of serumal calculus presenting sharp angles. Such a case cannot heal until these are perfectly removed. Still other cases will present a denuded apex of the root.

The first of these may be said to be incurable. True, by persistence in the use of antiseptics the time will come when the poisonous products within the substance of the root will be dissolved out, but it is too slow a process for recommendation. The second case may be cured by removing the calculus with proper shaped instruments, or reduced to the condition of the third class, in which the end of the root is simply denuded. In this class of cases, healing is exceedingly tedious, and if not very carefully watched they are constantly becoming re-infected, and that which has been gained is again lost.

Happily very few of the numerous cases presented in practice are of these varieties. Generally, even in cases of long standing, the only impediment to a return to health is the continuous infection of the tissues at the apex of the root with microbes, or the products of decomposition, from the root canals. Therefore, the treatment required is the thorough disinfection of these, and the replacement of the poisonous contents with some substance incapable of decomposition. This done, the tissues of the peridental membrane readily resume their normal condition. It is always best to stop the root temporarily, after having cleansed and disinfected it, so that it may be first ascertained if the work has been perfectly done, the test of

which is the disappearance of all symptoms. If there has been a discharge of pus, this should promptly cease. If there has been soreness on pressure, this should pass away within a few days. When this result has been attained the temporary stopping should be removed from the canals (the rubber dam being in position to prevent re-infection from the saliva) and the roots permanently filled with gutta-percha.

If in the first effort the case should not return to health in the course of a week or ten days, a new effort should be made. Should this fail also, it may be supposed that there is some impediment to a return to health beyond the apical foramen; and if there is a fistulous opening a probe may be introduced for the purpose of examining the apex of the root. Often it will be found necessary to enlarge the opening by tents or the knife. If the root is found rough from deposits of serumal calculus, it should be carefully cleansed and smoothed, or a portion of the apex may be excised. Then the treatment should be to render it as nearly aseptic as possible, and give it time to heal, using in the meantime only such treatment as may be necessary to maintain the aseptic condition. In those cases in which the membrane is parted from the root, micro-organisms become lodged upon its surface, and cannot be expelled by the tissues unaided. This condition calls for the passing of antiseptic remedies through the apical foramen for the dislodgment of these; and, also, much more time is required for a return to health than in the simpler cases. The treatment should therefore be repeated sufficiently often to prevent re-infection, or to disinfect promptly in case of re-infection of the parts.

The particular remedies employed are unimportant so long as they properly cleanse and disinfect the parts without material injury to the tissues, but for the worst class of cases peroxide of hydrogen should certainly be used before other disinfecting agents, for the reason that by its property of evolving oxygen gas it drives everything out of the abscess cavity, and places it in fit condition for the reception of other remedies.

In my practice, which has been large in this class of cases, success is obtained almost uniformly with a single treatment; certainly in as much as ninety-five per cent. of the cases presented. Of those that are not cured with the first or second treatment, a large proportion, about one-third, are finally unsuccessful.]

Tumors of the Periosteum.

Upon the apex of roots that have been extracted on account of chronic periostitis or acute exacerbations, there are occasionally found peculiar new formations, from the size of a pea to a hazel-nut. Their shape varies; generally the new formation is a compact round mass, but in one case I observed one which was 2 mm. in width and 2 cm. in length. They arise either at the apex or on the side of the root. One of their usual locations is between the roots of the molars, in which case the septum of bone between the roots is replaced by the new formation.

The structure of these new formations varies. Part of them consist principally of fibrous structure, similar to hypertrophy in cases of chronic inflammation. In other cases the structure is sarcomatous, and lastly there is formed from the root-membrane a cyst (see "Cysts of the Jaw"), of which a portion of the sac is generally removed in the extraction of the root. In one case, in a boy twelve years of age, I removed the entire cyst. It was attached to the palatal root of the upper left first molar, which was extracted on account of alveolar periostitis. The cyst, after having been in alcohol for nine months, still has a length of 3.5 and a width of 2.5 cm. Wedl has also observed a cancerous thickening of the root-membrane, but only in cases in which there was infiltration in the vicinity, so that the origin of the formation from the root-membrane is not probable.

Tumors of the root-membrane (except the larger ones that arise from the outer surface of the jaw) are, as has been stated, seldom diagnosticated. They may cause acute inflammation, and then lead to the extraction of the affected tooth. They may, also, without causing any symptoms, continue to grow and substitute the jaw. Many of the destructive sarcomatous formations of the upper jaw perhaps originate in this manner. In the lower jaw I have seen a sarcoma whose origin undoubtedly was the membrane of a root, and which substituted the lower jaw to such an extent that, corresponding to the location of the tooth, there was only a small rim of compact substance of the jaw-bone that had not been involved. Magitôt observed infra-orbital neuralgia and neuralgia of the tympanic plexus, which were caused by tumors of the root-membrane.

Luxation of the Teeth.—Replantation.

Sometimes the incisors are partially dislocated from their alveoli from blows or a fall. Occasionally, from carelessness during the extraction of a diseased tooth, its healthy neighbor is either luxated or extracted with it. The loosening of the tooth occasions an enlargement of the alveolus, a displacement of one of its walls. By luxation we mean that the tooth was simply raised but not entirely removed from the alveolus.

The treatment consists simply in pushing the tooth back into its position, and the displaced walls are pressed in the best possible manner against the tooth. After-treatment consists of cold water applications. The tooth, as a rule, unites, and may remain for a number of years.

[Supposing that the author has only intended to speak of teeth that have been loosened up from their alveoli without any solution of continuity of the gums, the treatment is sufficient for the time being. But I will add that in these simple cases it is often much better to so confine the teeth in their positions that they will not be constantly moved by the motions of the organs of speech and mastication. The plans of doing this in individual cases must depend upon the genius of the surgeon. The teeth may be confined by securing them to neighboring teeth with ligatures or with wire; by a gutta-percha plate moulded to the parts with the fingers, or otherwise, and secured in place with ligatures when it does not remain firm enough through contact with neighboring teeth. Or metallic caps may be struck up to fit the crowns of the teeth, and secured by cement. But another and more important point in these cases is the condition of the pulps of the teeth. In a large proportion of them the effect of the luxation will be the death of the pulp. Therefore the teeth should be carefully examined with reference to this at as early a date as possible, and the condition of the pulp ascertained. Naturally this cannot be done at once for the reason that the sensations of the pulp, if living, will be annulled by the soreness of the teeth. Therefore it is best to wait until this has passed away sufficiently for the application of the temperature test. In otherwise healthy patients this delay is not likely to do harm, if not too long continued, for suppuration is not likely to occur for a considerable time.

When the pain and soreness have somewhat abated, ice or a hot

instrument should be applied, first to a healthy tooth in order to instruct the patient as to what he should expect. Then a like application should be made to the injured teeth, one after another, and the fact carefully ascertained as to whether the same sensations are produced in these. If such is the case the pulps are alive and all is well; but if not, the pulps are dead. In this latter event the pulp-chambers should be opened, and the dead pulps removed at the earliest practicable moment, or as soon as the teeth are firm enough in their injured alveoli to bear the drilling without danger of injury, or of producing too much pain. In such cases, as said above, decomposition of the pulps and suppuration is not likely to occur for some time; but it is likely to occur, we may say, will certainly occur, sooner or later, and if the operation is delayed a close watch should be kept for symptoms indicating it, notably increased soreness of the teeth; and if this occurs the operation should be performed at once. The roots should be filled at a proper time, or after all conditions seem favorable.]

Replantation.—If the tooth has been entirely disconnected from the alveolus, it may be implanted within a few hours with prospect of re-attachment taking place. Naturally the root should be treated antiseptically before being re-implanted. If the alveolus is already somewhat smaller and filled with coagulated blood it is good practice to resect a portion of the apex of the root. It has been attempted to replant decayed teeth after having accomplished their filling outside of the mouth. The indications for this procedure are rare. In most instances the tooth can be retained in the mouth by antiseptic treatment, and only when this cannot be done, as in cases of necrosis of the apex of the root, it may be recommended that the tooth be extracted, and after the resection of the necrosed portions, be re-implanted, provided the retention of the tooth is sufficiently important to warrant it.

As to the process involved in the re-attachment of replanted teeth there is much question whether the pulp becomes re-attached or not, whether the periosteum re-unites or whether the changes taking place resemble the attachment of ivory within tissues; that is, that the root becomes partly resorbed, and that the bone-marrow that has occasioned the resorption becomes ossified. There is no doubt that under different circumstances any of these three processes of healing may take place.

Young teeth, whose roots are not yet fully developed, will undoubtedly entirely re-unite themselves after replantation, and receive their full development. The soft pulp is still dentine germ, and is in its greater part connected with the dental sac. The alveoli are not yet compact. The connective-tissue stratum, which assists in re-establishing the connection, is present in large quantity, and thus the healing of the pulp cells, as well as that of the periosteum is made possible. A young replanted tooth may become re-attached as perfectly as a piece of replanted bone, or as any other part of the body that is rich in vessels.* Teeth whose roots are fully developed, and that are replanted while having part of the healthy periosteum attached, most likely become refastened by a union of that periosteum with what had been left in the alveolus, although the pulp in these cases does not form organic union as a general rule. Only in exceptional cases, and in consequence of a fortunate bringing in contact of the several parts, may there occur a reunion of the pulp of fully developed teeth.

Teeth replanted after the removal of the shreds of periosteum attached to them, must be held in the jaw by mechanical means. That the alveolo-dental periosteum remaining in the alveolus cannot attach itself simply to the root cementum is evident from the fact that the connective-tissue elements of the cementum, from which the cell-proliferation would have to originate, are too small in quantity. In addition to this, the tooth is too loose in the alveolus, in consequence of the loss of the periosteum. In order to explain the process of healing in these cases we must first observe the changes taking place in the obliteration of the alveolus after extraction of a tooth. In regard to this subject we have an excellent work by Baume (*Vierteljahrsschrift für Zahnheilkunde*, 1871, page 277). In the place of the blood-clot, there is formed a richly vascular granulating structure, and which generally grows from the bottom of the alveolus. In the granulating structure particles of bone are formed, which become more numerous in course of time, and finally the entire granulating structure is replaced by one resembling osteophytes. This becomes thickened into a spongiosa.

If a tooth is placed in an alveolus where the walls do not come

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* Proofs in behalf of this assertion have been given in a lengthy discourse on this theme: See Parreidt, *Zahnärztl. Mittheilungen*, Leipzig, 1884.

in contact with the tooth, the process just mentioned will take place only in that portion of the alveolus not occupied by the tooth. Taking it for granted that the tooth is not properly fastened, the space between itself and the alveolar wall will become filled with spongy bone tissue. This becomes thickened and smooth by the frequent pressure the tooth receives during mastication, and the conditions at a later period are very nearly the same as before extraction. It is possible that between the alveolar wall and the teeth a remnant of the granulating structure should remain as connective-tissue membrane, and this membrane may here and there unite with the cementum. The union will be more extensive and more intimate if small portions of the periosteum have remained on the root. If the tooth is not re-attached, ossification is disturbed and the granulation-tissue either disintegrates by forming into pus, or fibrous bands are formed—just as fractured bones heal by the formation of fibrous bands when the fractured ends are not fixed together. With the process of new tissue formation during re-attachment of replanted teeth resorption also takes place. Sometimes compact tissues, formerly the alveolar walls, are pierced by the bone-marrow of the spongiosa, as in the healing of wounds after extraction. In other instances, the roots of the implanted teeth are resorbed by the growing granulation-tissue, which produces the hemispherical points of resorption. If the granulation-tissue also ossifies in these excavations, as is generally the case, the tooth becomes firmer than a normal tooth. The statement of such as have extracted replanted teeth, as to the difficulty of extraction, is explained by this fact.



Fig. 18.

Replanted tooth showing absorption.

Sometimes the granulation-tissue does not ossify, but continues to grow, until finally the greater portion of the root is resorbed. In consequence of this the root becomes loose, and can be finally removed with the fingers, as has been observed by myself (See Fig. 18) and others (Tomes, Balkwill).

CHAPTER VI.

DISEASES OF THE ALVEOLAR PROCESSES.

Fracture of the Alveolar Process.

Fracture of the alveolar process is caused by a blow against the teeth, by which the latter themselves are loosened. As a general rule only one of the alveolar walls, either the labial or lingual, is fractured by the pressure extending over a few teeth. At the same time the gums are frequently more or less lacerated, remaining, however, as a rule, sufficiently together to prevent an entire separation of the broken piece of bone from the organism. Since no muscles are attached to the alveolar processes, the position of the dislocated fractured piece is not subject to any rule, but it generally remains in the position given it by the trauma.

The treatment is confined to pushing back the teeth and the fractured bone into their normal position. They are then held in position by a rubber-plate or by wires for several weeks, in a manner similar to that for the treatment of fractures of the jaw, as explained in the succeeding chapter. As no muscles are attached to the alveolar process the fractured portions can be readily replaced.

[In all cases of fracture of the alveolar process, especially when accompanied by luxation of teeth, if the parts have been so displaced that the saliva has had opportunity to enter the wound, it is very important that it be disinfected before the replacing of the fractured parts is undertaken, in order, if possible, to prevent suppuration. This is best done with a solution of bichloride of mercury in peroxide of hydrogen. For small wounds, such as those in question usually are, it may be used in the strength of 1 to 1,000, or even 1 to 500. This solution should be injected into every part of the wound, and while it is in active effervescence the replacement should be made quickly, forcing out the fluid by this act. Then, if compression is made by the arrangement of the splint, pus will probably not form at all, or will be confined to superficial parts of the wound.]

A fracture of the outer lamella of the alveolar process often occurs during the extraction of the upper molars, seldom with the lower. On the upper molars the outer alveolar wall is so thin that in the expansion of the alveolus necessary in the removal of the tooth a disconnection may readily result. In a smaller number of cases, when the lamella is exceedingly thin, a small portion of it will break off entirely during extraction, and it is recommended in these cases to remove the part still attached to the gums, since otherwise it may become necrosed and lead to the formation of pus. In case of fracture, nothing further is necessary than to press the alveolus back into its proper position. Under the former extensive use of the key for extraction of teeth fractures of the alveolus were more frequent than at present. These differ from fractures caused by concussion in that the fractured piece of bone is separated from the remaining adjoining teeth, while in cases of concussion the teeth are dislocated coincidently with the piece of bone. When such fractures from extraction with the key occur now, it is always advisable to cut away from the gum the lamella of bone that is separated by the teeth, since re-attachment can hardly be expected.

Alveolar Periostitis, Alveolar Abscess, Gingival Fistula.

Inflammation of the alveolar process of the jaw can scarcely be considered separately from inflammation of the root-membrane. Some authors even consider it as the second or third stage of root-membrane inflammation. There are, however, undoubtedly cases of pus-formation from root-membrane inflammation, in which no swelling of the outer alveolar periosteum is present. Even if it is not questioned that the portions of the alveolus adjoining the root-membrane are also inflamed, the outer periosteum may be free from inflammation, and in this respect a dental periostitis is differentiated from an alveolar periostitis. In most cases root-membrane inflammation undoubtedly leads to alveolar periostitis.

An examination reveals that generally on the buccal surface (very seldom on the lingual), there is pain on pressure, and diffuse swelling which is the result of pus infiltration. In the vicinity there is more or less œdema, which leads to disfigurement, if the lips and eyelids are involved. In cases of alveolar periostitis in the lower jaw, sometimes the sub-maxillary and lymphatic glands are swollen and painful. The cheeks are warmer than on the healthy side. An

examination of the mouth shows that the gum around a diseased tooth and both adjoining teeth is considerably reddened, and somewhat swollen. The greater swelling is opposite the apex of the root, and in this position the division between the gums and the mucus membrane lining the cheek is obliterated. The tooth in whose vicinity these symptoms of inflammation are most prominent is decayed into the pulp chamber. The pulp is gangrenous or has disintegrated into watery pus. Upon pressure, or even upon slightest contact, the tooth is found to be painful and loose; hence there is inflammation of the root. In some cases, especially the less acute, inflammation of the root-membrane may have almost or entirely disappeared at the time when the outer alveolar periosteum is inflamed.

If the inflammation is allowed to take its own course it will form an abscess (alveolar abscess, parulis, tooth abscess, gum-boil). Opposite the root of the diseased tooth, within the mouth, fluctuation may be felt, which, however, is sometimes difficult of definite determination, especially when the abscess in the upper jaw is high up, or in the lower, far down beneath the cheek. The abscess breaks, and a fœtid pus is discharged into the mouth. The discharge continues actively for several days, and then gradually diminishes, but in most cases does not cease spontaneously, and a fistula remains. If but a small quantity of pus is discharged, the opening is sometimes again closed. In the course of a renewed subacute inflammation a small sac is formed, which either opens of its own accord, or may be opened and evacuated by the patient. The pus discharges, the slight pain disappears, and the trouble ceases for from several days to several weeks. Teeth that have fistulas, show at the same time symptoms of chronic inflammation of the root. If they are extracted the apex of the root will be found either covered by thickened periosteum or roughened as a result of its maceration in the exudate, and it is necrosed.

Sometimes the discharge of pus is so copious that every hour a few drops of pus will be discharged on pressure. At the same time there is a slight swelling near the fistula, showing that the alveolar periosteum is also inflamed. This inflammation is at times so acute that small sequestra of bone are thrown off. If the alveolar periostitis becomes chronic at its commencement, a tolerably hard, elastic swelling is developed, which is slightly painful and may remain unchanged for months and years.

Idiopathic Alveolar Periostitis.

Occasionally alveolar periostitis will occur in teeth that are not carious, the cause of this being entirely unknown. [In this case as in others, if the abscess have its seat at the apex of the root of the tooth, it is an after-effect of the death of the pulp of the tooth. The cause of the death of the pulp may, however, be entirely unknown. Such cases occurring in teeth that are entirely free from caries are not very uncommon.] There is a slight but plainly defined swelling on the buccal side of the alveolar process, which is painful on pressure. One or two teeth, whose roots project into the swollen parts, show symptoms of an acute or sub-acute inflammation of the root. Generally these are incisors, less frequently bicuspids and molars. At the beginning it is uncertain whether there is pain in the tooth, but before an acute inflammation of the root can be diagnosticated with certainty, it is followed by a swelling of the alveolar periosteum. The inflammation lasts generally from eight to fourteen days. During this time the swelling remains of the same size. It then gradually diminishes, and finally disappears without leaving any signs of its previous existence. In some cases, very seldom, however, abscess will result; in others pus is discharged near the affected teeth between their necks and the gums. The inflammation recurs sometimes after months and years in the same person and on the same teeth, and sometimes on other teeth of the same person.

[The disease here described is in America universally regarded as apical alveolar abscess, or a condition resulting from an inflammation having its beginning and seat in the apical portion of the peridental membrane and, following, either closely or at a more or less remote time, the death of the pulp of the affected tooth or teeth.

There are, indeed, some rare instances of true alveolar periostitis in which the teeth are not involved, but these generally present different symptoms; very generally the periosteal inflammation has begun upon the bone proper rather than in the process, and runs its course quite differently from alveolar abscess.]

Treatment of Alveolar Periostitis.

Prophylactic treatment of this disease is the same as that employed for caries and pulpitis, because caries leads to destruction of

the pulp, and later to inflammation of the root-membrane, and this finally results in alveolar periostitis, with all its consequences.

If alveolar periostitis is present, the retention of the affected tooth is not impossible, but it is uncertain, and to be successful requires much care under any circumstances. Hence conservative treatment should be resorted to only for such teeth whose retention is of much importance; in other cases extraction is to be recommended.

Many physicians are of the opinion, that during the existence of inflammatory swelling the teeth should not be extracted, and that the inflammation would be intensified; but this is an error. If sometimes in exceptional cases the processes of disease continue after the extraction of the tooth, this is not the result of the operation, but something that would have taken place in spite of it. But in the large majority of cases the inflammatory process ceases immediately upon the removal of the tooth causing the disease; and many cases get worse because extraction is postponed.

Conservative treatment of alveolar periostitis is begun, as in inflammation of the root-membrane, by first opening the pulp-chamber in order to furnish an exit for the foul fluid and the gases of decomposition from the root-canals, and then permitting the discharge of the pus that has already collected about the apex of the root. The patient is advised to rinse the mouth frequently with some antiseptic solution; as a general rule, the following day pain will have been diminished to such an extent that the cavity can be cleansed entirely. The tooth is then left open for several days, and after the swelling of the alveolar process has disappeared, treatment is continued in the same manner as in gangrene of the pulp or dental periostitis.

If an abscess is already formed it should be lanced immediately, and the treatment of the tooth begun the next day. If a tooth is to be extracted while an alveolar abscess is present, this may be done immediately without hesitation. The pus discharges freely through the alveolus with which the abscess communicates. But sometimes this communication is not sufficient, and it is necessary to lance the abscess afterwards. In cases of persons that fear the operation, the abscess, if showing plain signs of fluctuation, may be lanced, as a rule, on one day, and the tooth extracted the following day. The pain and other symptoms of disease diminish immediately after the lancing, and the extraction is less painful the following day.

Gingival fistula is often healed by antiseptic treatment of the tooth from which it arises. The residuum of the fistula remains as a small swelling of the bone. In some cases fistula, however, will not yield to such treatment, while in others a cure may take place without any treatment. Cases in which the formation of pus is abundant appear to be incurable; the tooth thus involved should be extracted. Sometimes replantation has been resorted to in these cases, but as a general rule these teeth are not sufficiently valuable to justify the attempt.

In chronic alveolar periostitis, also, if it is not cured by antiseptic treatment of the tooth, extraction is recommended. Patients generally do not wish these operations performed, because they do not want to have a tooth removed that causes them no pain. It is our duty, however, to call the attention of patients that have placed themselves in our hands to the consequences resulting from decaying teeth or roots in the mouth. In these there is a continual production of septic masses, which become mingled with the food during mastication, that cause impurity of the inspired air, and that are objectionable on account of the disagreeable odor they give to the breath. Sometimes chronically inflamed roots lead to subacute and acute exacerbations, and more or less pus is produced, which may possibly be resorbed by some means, and in some way either by the lymphatic vessels or the circulatory system, be led into other tissues and organs; and when deposited in them may lead to various disturbances.

For idiopathic alveolar periostitis not much can be done from a therapeutic standpoint. The treatment is confined to painting the circumference of the inflammation about the gums with tincture of iodine, thus causing counter-irritation. As the inflammation in these cases is generally subacute, and pain on pressure is only slight, it may be sought to hasten absorption by copious rubbing of the ointment of iodide of potash into the skin. If the inflammation is acute and leads to an abscess, the discharge of the pus will be followed by cure. A sound tooth in which this inflammation of the root-membrane is present need not be extracted in these cases.

Ostitis and Partial Necrosis of the Alveolar Process.

In very rare cases the inflammation of the root-membrane instead of being continued in the alveolar periosteum encroaches in the direction of the body of the jaw. In these cases the inflamma-

tion, as a general rule, is very acute. The entire alveolar portion of the bone surrounding the diseased tooth and its neighbors is swollen, painful, and soft, on both the lingual and labial surfaces. As early as the fourth and sixth day, an abundance of pus oozes from under the border of the gum near these teeth, and from a number of fistulæ opening in the gums. The fœtor from the mouth is very prominent, and the teeth are loose, for they are imbedded in carious bone.

If the inflammation continues for weeks, and if it is very acute, sequestra are thrown off from the alveolar process. The vessels supplying the pulps of the healthy teeth, adjoining the diseased one causing the inflammation, are sometimes compressed by the exudate in the bone to such an extent that their pulps die. At the same time the root-membrane is bathed in pus. Such teeth, if they are allowed to remain, keep up suppuration and sequestration of bone. Sometimes a sequestrum requires an unusually long time until it is thrown off, because the tooth which projects into it, holds it in position, and the sequestrum is simply removed when the tooth is extracted.

The treatment of ostitis consists in immediate removal of the diseased tooth. It is remarkable how rapidly improvement follows. In three or four days the parts are almost normal. If, however, the inflammation has cut off nourishment from portions of the bone, the formation of pus may continue for weeks and months, or until the sequestra can be removed, which sometimes necessitates the removal of the healthy tooth adjoining the diseased one.

In cases of pus formation from dead bone in the mouth a solution of bichloride of mercury, 1 in 3000 is to be recommended for rinsing the mouth. It is a much better disinfectant than a 2 in 100 solution of carbolic acid, or permanganate of potash in a rose-red solution.

Pyorrhœa Alveolaris.

The most remarkable symptom of this disease is the chronic discharge of pus from the alveoli of one or more teeth. Decay has nothing to do with this disease, as it is more frequent in the alveoli of sound than of carious teeth. Pyorrhœa is most frequent on the incisors, occasionally appears on the bicuspids, and is least frequent on the molars. Only a few teeth are ever affected, never the entire arch.

At the beginning of the disease there appears between the gum and the neck of the tooth a drop of pus, when pressure is made with the finger upon the gums, in the case of the upper teeth from above down, and in the lower teeth from below upward. The gum appears livid, and a pocket is formed on the tooth, in which the pus is held. These pockets do not reach at first around the entire tooth, but are either on the lingual, labial, or on one of the approximal surfaces. As the disease progresses the pockets become broader and deeper, reaching as far as the alveolar border and encircling the tooth; the quantity of pus discharged increases proportionately.

In the meanwhile—several years may pass, in some cases but a few months,—the same process appears on another tooth, not necessarily on one contiguous to the first; more often one or more teeth are skipped. In course of time the number of teeth thus affected increases. The gums do not reach as far as the enamel, but gradually recede, and the roots of the teeth become exposed. If half of the root is thus exposed, and the tooth consequently loosened, its movement causes inflammation of the gum, which, in the beginning, was only of a bluish red color and hardly any, or not at all swollen or painful. In consequence of constant looseness of the tooth the gums become swollen where they encircle the root, and they bleed very readily. Severe pains follow, which finally lead the patient to have the tooth extracted.

Less frequently the origin is acute, the pyorrhœa resulting from an acute alveolar periostitis, leading to discharge of pus near some tooth, which afterward becomes chronic.

In regard to the nature, etiology and treatment of alveolar pyorrhœa there is not much that is positively known.

Most frequently the tartar that has accumulated under the border of the gum has been regarded as the cause of alveolar pyorrhœa, and in many cases in which a complete cure has resulted upon its removal, it is possible that the disease was due to the irritation of the tartar.

But these are not typical cases of alveolar pyorrhœa, for in typical cases after the removal of tartar the disease is not easily cured, and sometimes not at all. In addition, the quantity of tartar which is found on the affected teeth is generally not large; and finally, there are cases in which not the slightest particle of tartar can be found.

Such a case, which was interesting in several particulars, was observed by me in a gentleman thirty years of age, who keeps his teeth in a very clean condition, and whose dentures I have examined semi-annually since 1878. In 1882, at one of these examinations I found that when pressure was brought to bear on the slightly darkened gums over the upper left central incisor a small quantity of pus oozed out from under the border of the gum on the lingual side. As no other tooth was affected in any such manner, my diagnosis was doubtful, but I recommended the patient to press the gums in a downward direction daily, morning and evening. In June, 1883, I again examined the teeth and was enabled to diagnosticate alveolar pyorrhœa with certainty. The patient (who no longer lives in Leipzig) informs me that the gums occasionally feel loosened at the point in question, and especially so after smoking. I recommended nothing but the frequent evacuation of the pocket by pressure, and rinsing the mouth with a solution of permanganate of potash. With this treatment the disease has made no farther progress up to the present time.

Pyorrhœa has also been considered a symptom of general disturbance. It is especially claimed by various authorities that it is a constant symptom of diabetes. But such is not entirely true. It occurs in many diabetics, but is not present in all cases. On the other hand, it should not be believed that diabetes is a constant cause of pyorrhœa. I know a number of persons that have suffered from pyorrhœa for six and eight years, and longer, but in whose urine, repeated examinations did not show the presence of sugar.

Witzel is of the opinion that pyorrhœa of the alveoli results from infection, and he named the disease infectious alveolitis. Observation leads to a contrary view, because, as a general rule, the alveoli of the adjoining teeth are not infected, but more frequently one or two teeth are passed over.

[After much careful observation of this disease, I am satisfied that whatever be the nature of the cause it is a specific disease of the peridental membrane, and that the condition of the alveolar walls is secondary, or a result of the principal affection. The pockets that form beside the roots of the teeth are deepest next to the cementum, and often pass much below the margin of the alveolus before the alveolar wall is in any degree affected. Again, I have often had occasion to examine cases in which the membrane of one

tooth was deeply affected on its proximal side, while that of the neighboring tooth was not, and have generally found that the alveolar wall of the healthy tooth was left intact as well as its membrane. I have such a case under treatment at present, in which a thin flat blade passes down the anterior proximal surface of the anterior root of a first molar three-fourths its length, while both the membrane and the immediate alveolar wall of the adjoining bicuspid are in good condition. In such cases I cannot suppose that the disease is essentially of the alveolar wall. The destruction of the fibers of the peridental membrane at their junction with the cementum is the most constant and marked effect of the disease. From examinations recently made it seems probable that this disease really follows the lymphatics of the membrane which lie very close to the cementum. That the disease is infectious there seems to me to be no doubt whatever, yet this has not been proven in a manner that satisfies the exacting demands of scientific accuracy. Although I have made many cultivations of microbes from the pockets, I have not been able to demonstrate that any one species is peculiar to it, and as no animal, thus far, is known to be susceptible to the disease, experimentation is limited to the human subject, which is practically prohibitory.]

As regards the pathological anatomy of the disease, that view seems most probable that attributes the discharge of pus to a chronic inflammation of the alveolar process (caries of the limbus alveolaris). This causes a rarefication of the alveolar border, and it will be found that the gum for the distance of several millimetres lies only loosely against the tooth, and that in the pocket thus existing between the tooth and the alveolus, the alveolar border is found far up in the upper and low down in the lower jaw. The inflammation is possibly caused by mechanical irritants, which are frequently present in the mouth. It is only necessary for a very small morsel of bread-crust to become lodged under the free edge of the gum, and thus to cause such an inflammation in a person in whom pus-formation readily takes place. In this sense tartar may be considered as one of the causes, as it is certainly a mechanical irritant to the gums. If the formation of pus be once established, the stagnation of the exudate in the pockets of the gum is sufficient cause to continue the pus-formation. Predisposition must be considered, as such small mechanical irritants are frequently present without leading to

chronic discharge of pus. The fact that persons suffering from diabetes are so frequently subject to pyorrhœa may be due to the well-known disposition of such persons to pus-formation.

The livid appearance of the gum is due to venous stasis, which is always more or less present in the vicinity of inflammatory groups. That in cases in which such stasis exists, inflammation of the gums is easily established, may be readily understood, if the tooth is loose, and by its movements presses pus into the meshes of the gum-tissue. The treatment consists, above all, in the utmost cleanliness of the mouth. All tartar must be removed from the teeth, and the patient must be advised to brush the teeth at least three times a day. The pockets in the positions mentioned should be pressed out and the mouth rinsed with antiseptic liquids. Although such treatment does not cure the disease, it prevents its progress. I have had under observation for eight years cases that by this treatment have not progressed. Injections of the various antiseptic and astringent remedies (chromic acid, carbolic acid, solution of nitrate of silver, chloride of zinc, chlorate of potash, permanganate of potash, iodoform, corrosive sublimate, etc.) have but little more influence than simple cleanliness. Neither is the washing out of the pocket, as recommended by Witzel, followed by any favorable results. In one case I divided the gum in order to be able to disinfect the pocket more thoroughly, but after the gum had entirely healed the former condition again appeared. I would place the most hope for success on the removal of the gum, and the scraping of the carious border of the alveolar process. The defect is again covered by the gum.

If the tooth is already markedly loosened, and there is swelling and pain in the gums, the probability of saving the tooth is very slight and extraction is recommended. This is followed by a cure of the inflammation of the gums and the pyorrhœa.

[The treatment that I have employed for this affection has, I may say, been fairly successful, very nearly all cases that have not yet progressed so far that there is decided loosening of the teeth, yielding to it, and many of these later recovering so far as to be useful in mastication. The treatment consists in thorough and persistent disinfection of the pockets in the alveolus of the infected teeth. It is begun by thoroughly cleansing the portion of the root denuded of its membrane with suitably formed, very thin instruments that may be passed to the deepest parts of the pockets without

necessarily injuring the soft parts. Even in the cases in which no calculus can be found the surface of the denuded portion of the root is coated with inspissated mucous débris, and micro-organisms, and these must be removed. The pockets are then cleansed twice a week with peroxide of hydrogen followed by some good reliable disinfectant, which is injected to the bottom of the pocket with a suitable syringe. The nozzle of this must be small enough to pass between the gingivæ and the neck of the tooth without any strain upon the soft tissues. This treatment must be persisted in regularly for weeks, and if necessary for months together, without a skip or break. When this is done we very generally have the satisfaction of seeing the parts gradually assuming the normal condition, and often the membrane is reformed where it had been detached from the root and the teeth become permanently useful. I have now under frequent observation a number of persons who have for several years been chewing their food well on teeth that had been so loose from the effects of this disease that they could not be kept in line, and for this reason became fixed in somewhat irregular position.

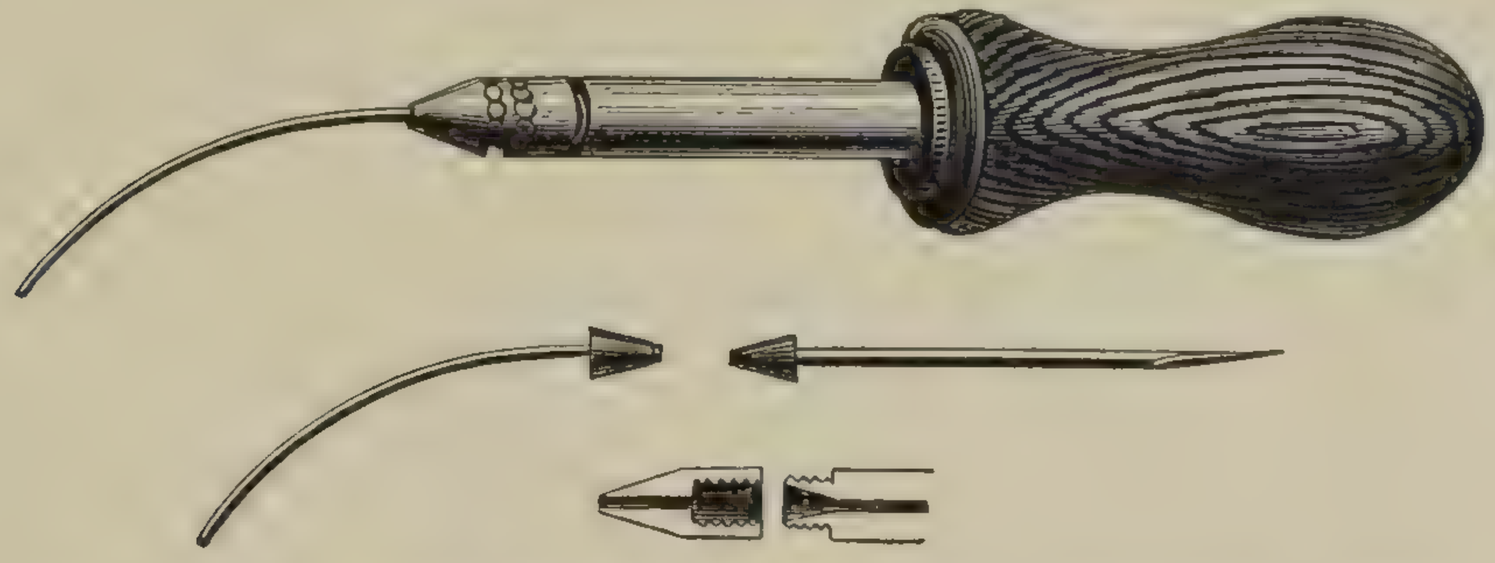


FIG. 19.—*Dunn's Medicinal Syringe, with Adjustable Needle.*

The instruments best adapted to the medicinal treatment of this disease are Farrar's abscess syringe, and J. Austin Dunn's drop syringe. (See Fig. 19.) The former has a very delicate gold nozzle that is easily passed under the free margin of the gums and up into the pockets, and the piston is arranged to work with a screw by which a single drop of fluid may be forced out of the delicate tube in any position. Dr. Dunn's instrument consists of a very delicate gold tube to which is attached a rubber bulb; and while it is fairly well adapted to the work, it is much less expensive. It is also well adapted to the treatment of abscesses about the mouth.]

Alveolar Atrophy.

The alveolar process belongs without any question to the teeth. It is developed with them during their eruption, frequently becomes diseased in connection with them, and disappears after their extraction. It also is removed during senile atrophy and in these cases the teeth disappear with it ; in other words they become loose and drop out.

The eruptions of the teeth from the alveolar process in youth occur through a slight irritation caused by the enamel, which is at this time not nourished on account of the entire calcification of the enamel-organ ; this irritation is exerted upon the bone, which is therefore absorbed and continues to be absorbed until that portion of the tooth covered by the enamel is entirely without the bone. The bony structure has then no more reason to be absorbed, and readily remains in contact with the cementum, which is covered and nourished by the root-membrane.

At the margin, where the enamel and cementum meet, the root-membrane is reflected on the outer surface of the alveolar border, and thus becomes the external periosteum of the alveolar process. This membrane is at the same time so closely united with the gums that anatomically it cannot be separated from it.

In consequence of the retarded changes in the tissues during old age, the alveolar process becomes used up more rapidly than it can be reproduced (on account of the lack of Haversian canals in these positions). The alveolar border recedes, and as the gums are united with the periosteum, and the latter with the root-membrane of the tooth, they also must recede from the root. The tooth does not become lengthened, because there is no deposit of bone at the floor of the alveolus corresponding to the apex of the root, but in consequence of atrophy of the alveolar border it is exposed beyond the border of the enamel. An exception is found in those teeth that in earlier life become lengthened because they have no antagonists. Such teeth are raised from their sockets by a slight deposit in the floor of the alveoli, because the bone is deposited in the direction of least resistance.

In senile atrophy the progressive exposure of the root gradually causes looseness of the tooth, and if, during mastication, such a tooth is unconsciously pressed sideways, there occurs a rupture

on one side and pressure on the other side of the root-membrane, resulting in pain, for which the patient seeks relief by extraction of the tooth. Occasionally the loosened tooth remains in its position until at some time during mastication its connection with the gum is entirely broken; for finally the tooth is retained in its position in the gum only by connection of the thickened periosteum at the apex of the root.

It will be thus observed that if the teeth are not lost in earlier years from caries, they disappear in old age by atrophy. In many persons, even at the age of thirty-five, recession of the gum may be observed. The average age at which the teeth are lost is from sixty to seventy years. Nevertheless, I have seen all the teeth exceptionally firm in the case of a person of eighty-five, while on the other hand I have observed atrophy to begin even at the age of twenty, to such an extent as to cause loss of teeth; but usually not until after the fortieth year. In this respect the teeth seem subject to the same fate as other epidermic appendages, such as the hair, etc.

The early loss of the teeth is perhaps also to be noted as a symptom of trophic disturbance in the case of ataxic persons. This disturbance is brought about by sclerosis of the origin and of the fibres of the trigeminus. In some cases of this kind, in which the rapid and successive loss of teeth is a prominent phenomenon of disease, the nucleus of the trigeminus and the Gasserian ganglion have been found atrophied. In diabetes atrophy of the alveolar process is to be regarded as a symptom of the general process of emaciation.

[It is probable that among the people with whom I am associated there is not so great a tendency to the loss of the teeth from wasting of the alveolar process described above, as among those with whom the author is familiar. At any rate, in my acquaintance I find a goodly number of persons who have retained their teeth firm in their alveoli to a good old age, and I have had good opportunity for comparison of these with those in which the symptoms described above have been presented. I am of the opinion that the difference is one of personal habit. In our observation of people we find the greatest difference as to the cleanliness of the teeth, independently of the habitual use of the tooth-brush, etc. Some persons who never use a tooth-brush have habitually clean mouths, while others have not, and cannot have, except with the utmost care.

Now if we follow up this disposition in our examination of cases, we will find that those persons whose teeth are habitually clean will retain them firm in their alveoli to old age, even to eighty or ninety years, if they should be so fortunate as to live so long, while those with whom the case is the reverse the teeth will be lost by wasting of the processes. Want of cleanliness of the teeth, which seems to be in a large sense a physical habit, may be artificially corrected, and this seems to answer the purpose in proportion to the perfection with which it is carried out. I conclude, therefore, that want of cleanliness is the basis of this wasting of the gums and alveolar processes in advanced age. This is the result of more or less continuous irritation of the gingivæ by the products of fermentation going on in material that collects about the necks of the teeth. The correction of this must be a life-habit. I do not think it can be successfully corrected in old age, or after the difficulty has so far progressed that attention has been called to it by the loosening of the teeth; for at that time the form of the gingivæ and borders of the alveolar processes have become so changed, that semi-pockets are formed that favor lodgments. Still, much may be done to delay the evil results.]

Epulis.

On the alveolar portion of the jaws there is frequently developed a tumor, designated as an epulis, but which, contrary to what its name would imply, is attached to the bone and not to the gums. The tumor has the appearance of normal gum tissue, or is somewhat darker and reddened by venous hyperæmia; to the touch it is soft. On the under surface it is attached either by a broad base, or, as is more often the case, it is pedunculated. Occasionally, it has its origin from the root-membrane of a tooth, it may be within the bone and replace a portion of it. In extracting such a tooth—which is usually the remnant of a root—a portion of the tumor, that is firmly adherent to the cement, is brought away with it.

A microscopical examination shows the epulis to consist usually of spindle, stellate, or round-celled sarcoma. Fibromata, which are occasionally found on the alveolar portion of the jaws, may be also designated as epulis. Sarcomatous epulis is tolerably vascular; as a rule its base is entered by a large central artery from the bone. Its nerve supply is small.

So long as the swelling is small it causes no inconvenience. Only when its size exceeds that of the crown of the tooth does the deformity first receive attention, and principally because the tumor becomes frequently inflamed by contact with the teeth during mastication. The height of the crown of a tooth, therefore, is seldom exceeded by the epulis, while in breadth it may so increase as to exceed the size of a walnut. The cause cannot be ascertained in a large number of cases. Generally diseased roots, or the irritation of dentition is the cause.

[Epulis almost always has its origin in the irritation caused by a sharp angle of a broken tooth. It seems that occasionally when the crown of a tooth is partially or wholly broken away, so that a sharp angle is overlapped by the gum, the irritation thus caused produces a proliferation of the cells, and that in this way a physiological change occurs in some cases, by which this tendency to proliferation is continued even after the removal of the source of irritation, and the case passes into the condition found in true sarcoma. Hence, in some cases the mere removal of the outgrowth is not sufficient, but all of the affected tissue must be removed in order to effect a cure. In general, however, after the removal of the superabundant tissue, the broken margin of the tooth, or the entire root is sufficient.]

Treatment consists in the removal of the tumor. In cases in which the attachment is pedunculated, removal is secured by ligation. But afterwards the place of attachment must be powerfully cauterized, for the purpose of destroying all sarcomatous tissues and that there may be no recurrence. If one or more roots of teeth are enclosed within the tumor it is essential to remove them first. In these cases the tumor extends partially into the bone and must be removed with a sharp spoon-shaped instrument, or a galvano-caustic knife. Paquelin's thermo-cautery is also frequently used with good results for this purpose. In the same manner non-pedunculated epulis is removed as well as that attached to the periosteum.

If the epulis is again reproduced, the next operation must be made more thorough. The base of the enlargement must be removed, and hence the operation should include healthy tissues. If the irritation of erupting the teeth be the cause of the tumor, this will sometimes disappear after the eruption of the tooth in question. The following case is an example: In the case of a girl eight years

of age, there was a pedunculated epulis between the upper left central and lateral incisors, continuing to increase, and occupying the space of both of these teeth which had not yet been shed. As they were found to be loose in the swelling they were removed as the possible source of irritation. The tumor itself was cauterized every other day with nitrate of silver. Within a few weeks the permanent incisors were erupted, and the swelling disappeared from this place, while in the space of the lateral incisor it continued for six months, notwithstanding the continual cauterization; having remained until the appearance of the lateral incisor through the swelling; thus its eruption apparently causing atrophy of the latter.

Carcinoma.

In carcinoma of the gums and alveolar processes, of which only brief mention is made here, there may be observed the warty appearance of the exterior and the whitish cancerous exudate which is present between the warts. The mass of the tumor is less apparent than the great surface of ulceration. In response to questions the patients generally state that the disease was first noticeable after the extraction of some teeth. But it may be positively understood that cancer was the primary cause, and that the tooth was extracted because it was loose in the ulcerated tumor. The sub-maxillary lymphatic glands become infiltrated in carcinoma of the mouth, and it is well known that treatment consists in the entire removal of the diseased portions.

[Cancer occurring about the face, the lips, tongue, gums, etc., number more cases than those occurring in all other parts of the body combined. It is, therefore, a very important subject. The class of cancer occurring here is that known as epithelioma, which consists essentially of an extraordinary growth of the squamous epithelium of the skin, or oral mucous membrane, and presenting special characters. That this disease frequently has for its exciting cause the irritation produced by the sharp angles of broken teeth acting upon the overlapping gums, on the lips, cheek or tongue, can hardly be questioned. Therefore, especial care should be exercised in regard to such sources of irritation, especially in patients who have had cancer, or in families in which this disease has been known to occur among its present members, or in their ancestors. While I regard the exciting cause of cancer as being purely local and the

result of irritation there is undoubtedly a predisposition existing in the epithelium of some persons to this peculiar kind of excitation, and this predisposition is undoubtedly hereditary. As the general subject is fully treated of in works on surgery it is not so necessary that farther mention of it be made here.]

CHAPTER VII.

DISEASES OF THE MAXILLARY BONES.

In this chapter such diseases only will be considered as are of special dental interest. For others, the reader is referred to text-books on surgery.

Osteoperiostitis Maxillaris, Abscessus Maxillaris, Fistula Buccalis.

[The diseases treated of under this head are universally denominated as "Alveolar Abscess," by American writers.]

Alveolar periostitis is produced by infection from the infiltration of septic products finding their way into the bony structure through the dental canal, just as osteoperiostitis of the maxilla is caused by infection. Both are the same, as regards important features, that of the maxilla differing from the other mainly by the greater extent of inflammation and by the possibility of more serious results. The diagnostic difference between the two is therefore important. The inflammation that commences at the apex of a carious tooth in those cases in which it leads to periostitis of the jaw, passes rapidly through the bone and becomes localized on the maxillary periosteum. The swelling is greater than in alveolar periostitis, and in inflammation of the lower jaw is more deep-seated. In alveolar periostitis, pressure on the border of the jaw is not painful, while in maxillary periostitis, on the other hand, it will be found that the swelling extends from the outer surface of the jaw, over the margin, and that pressure applied at these points is as painful as on the sides. The œdema is greater, and there is always infiltration of the sub-maxillary lymphatic glands. Sometimes the cellular tissue of the neck is much infiltrated and very hard to the touch, during periostitis of the jaw.

In the mouth also, there will be found, usually, swelling and redness of the gum on the alveolar process, and the periostitic looseness of the tooth that is the result of the infection.

The skin of the cheek becomes gradually increased in redness on the most prominent portion of the swelling, and becomes shiny. Finally, after six or eight days, fluctuation is established, and the abscess ruptures or is lanced. After a free discharge of pus the inflammatory processes are diminished, and the swelling becomes reduced to a band the width of a finger, which extends from the diseased tooth into the direction of the opening of the abscess. The discharge of pus from the latter continues, and a fistula of the cheek, or a dental fistula, becomes established. The line mentioned, the infiltrated portion leading from the fistulous tooth to the opening on the cheek, which may be readily followed, shows the extent of the fistulous passage.

At the opening of the fistula during copious discharge of pus, there may be found granulations, but during slight discharge of pus these are absent. This often results in a temporary closure of the opening. The small quantity of pus collects under the thin skin-like covering, which becomes thinner by the continual collection of pus, and finally opens again. This closure of the opening, filling and breaking of the abscess, and discharge of the contents, is repeated every three or four weeks. After the discharge the abscess cavity is filled in each instance with granulation tissue, which is irritated and destroyed by the accumulation of small quantities of pus. The consequence of this condition is that the skin covering the abscess becomes entirely degenerated, and though the extraction of the fistulous tooth is followed by the cessation of pus formation, there remains nevertheless a soft fluctuating reddened surface at the point of the fistulous opening. If the fluctuating surface be lanced, there is no flow of pus, but there appear to be only granulations in a state of fatty degeneration.

These fistulæ often remain for years. I have seen some of seven years' standing. They do not heal until the diseased tooth is extracted. The particular tooth is not found readily, as it only shows the appearance of chronic periostitis, and such teeth or roots are generally found in large numbers adjoining one another. In certain circumstances a tooth which externally may have all the appearance of health may be the cause of a fistula, as will be shown later on.

In periostitis of the lower jaw the abscess and fistula are generally in the vicinity of the molars and beneath the border of

the jaw. In a few instances I have seen it on the chin, and in still rarer instances, namely, in inflammations that originate in the third molars, the fistulous opening may be at the angle of the lower jaw, or even further down on the neck, and sometimes on the breast. On the upper jaw it does not result as frequently in fistula of the skin as on the lower jaw. When it is present it is generally in the canine fossa, but it is connected with either the lateral incisor or the cuspid. There is seldom a fistulous tract above the bicuspids that burrows in a horizontal direction through the cheek.

From the upper molars it generally leads only to inflammation within the province of the alveolar process. If it extends to the jaw, pus-formation in the antrum of Highmore is established; or a fistula, which may communicate with this chamber.

[Occasionally a fistula leads from the roots of the molars of the upper jaw along the malar process, and is discharged on the face just in front of the attachment of the masseter muscle. The healing of this fistula usually leaves a very ugly scar, for the reason that by the contraction of the walls of the fistula, the inner end of which is attached to the periosteum, the tissues of the cheek are drawn inward under the molar prominence.]

Sometimes the inflammation originating from the apex of the root does not become localized within the periosteum of the jaw, but may lead to an acute osteo-myelitis of the jaw. The swelling, and the pain in such cases become intense, and the temperature may rise to 40° C. or over. Small portions of the alveolar process are cut off from nourishment, which later on lead to exfoliation through the mouth, or which may be removed through the fistulous opening on the cheek.

The production of pus is abundant, and fistulæ are produced sometimes hardly with sufficient rapidity. In the more severe cases, the pus may gravitate alongside the fascia of the neck into the pleura, with its serious consequences. In other cases, in consequence of the movements of muscles, the pus has followed the channels of the nerves and entered the cavity of the brain, through the foramen ovale or the foramen rotundum, resulting in death from meningitis. Death from œdema of the glottis has also been observed. Finally, extensive formation of pus within the jaw has occasionally resulted in death by septicæmia or pyæmia.

In reference to the differential diagnosis, several other affections

may be mentioned here, namely: those with which alveolar or maxillary periostitis, according to my experience, has been confounded. First erysipelas of the face may be mentioned. Confusion may arise if the swelling is regularly diffused, if it is not especially large at one particular point, and finally if the skin is equally reddened in consequence of irritation. In order to prevent errors of diagnosis, the mouth should be carefully examined, and the presence or absence of teeth suffering with periostitis be positively ascertained. In addition to this the border of the erythema of the skin should be observed. In erysipelas the borders of the erythema present the well-known sharply defined curved contours, while the redness occasioned by periostitis or inflammation of the skin does not have a sharply defined border. Inflammation of the jaw, however, may be accompanied by erysipelas. In such cases, both diseases should be treated.

In a case of idiopathic alveolar periostitis of the upper right central and lateral incisors, in which the upper lip was very œdematous, and in which the inflammatory infiltration extended the entire length of the nose up to the external angle of the eye, perichondritis of the nose was diagnosticated. A casual examination of the mouth and light touch on the anterior teeth, which were loosened and raised in their sockets would have led immediately to a correct diagnosis of the alveolar periostitis.

From an inflammation of the sub-maxillary lymphatic glands, periostitis of the lower jaw can be readily distinguished by the position of the swelling, which in lymphangitis is situated further underneath the jaw, and does not extend along its side. The pain that is present on pressure along the side of the jaw affected by periostitis is also lacking during lymphangitis. In addition to this, the swelling during periostitis is immovable on the under surface, whereas in lymphangitis the swelling is, as a general rule, movable to a slight degree.

Inflammation of the sub-maxillary salivary glands seldom occurs, and hence is not liable to be mistaken for periostitis of the jaw. Infiltration during such inflammation is most readily felt in the floor of the mouth, while the sides of the jaw are free from it. In differential diagnosis between angina Ludovici and periostitis of the maxilla, the structure of the teeth should receive special consideration. If the presence of dental and alveolar periostitis

can be established, the swelling on the neck and the lower jaw may be considered as resulting from the infection caused by the diseased tooth.

In one case at the surgical polyclinic a gummy tumor of the skin, in a decomposed state, and situated on the side of the lower jaw, was mistaken for a dental fistula. In favor of the latter diagnosis was the presence of a carious molar presenting unquestionable signs of chronic periostitis; but against such diagnosis the redness and infiltration in the vicinity of the swelling, and the circumstance that the skin was movable upon the jaw, seemed to be of some weight. In addition, the inability to enter any fistula with the probe was a valuable aid in the proper diagnosis. In favor of the presence of a gumma was a defect and a scar present in the uvula of the patient.

In the same way as the gumma was mistaken for a fistula, an inflamed sebaceous tumor if located in the vicinity of the jaw, and on that portion where there are chronic periostitic teeth, may be mistaken for a dental abscess. Such dental abscesses as are movable under the integument sometimes occur on the cheek, if the diseased tooth be an upper bicuspid. In cases of dental abscesses, however, there is an infiltrated line that leads from the abscess to the diseased tooth. In the vicinity of an inflamed sebaceous tumor the infiltration does not reach so far. Unless an upper molar is the cause, I have never observed movability of the swollen parts during inflammation, if they result from the teeth. Eventually an incision, which is necessary in either case if fluctation is present, will readily define the diagnosis.

As fistulæ of the upper incisors and cuspids are in close proximity to the nose in the canine fossa, they may be readily confounded with lachrymal fistulæ. But in these cases the infiltrated line, which can be followed (if it is a dental fistula) from the tooth to the opening, will be absent. In addition to this the eye should present certain indications that lead to a definite conclusion in regard to the presence of lachrymal fistula.

In two cases in my practice a fistula was erroneously diagnosticated to be carcinoma. In one case inflammation was especially prominent in the floor of the mouth, and an abscess on the lingual side of the lower jaw had just broken. In the other case the opening of the fistula was on the cheek opposite the bicuspid. The pus

formations and granulations at the opening of the fistula were extensive. A marked infiltration of the surrounding tissues was also present. The cheek was attached to the swollen gums, and was very hard to the touch. The affected tooth was already loose, and had caused ulceration of the gums and of the mucous membrane of the cheek. In the first case the acute progress of the disease placed the possibility of carcinoma out of the question. In the second case the ulceration, which was of several months' standing, more nearly resembled cancer. But even in this case an examination of the teeth would have led to a proper diagnosis.

The treatment of osteo-periostitis of the jaw consists primarily in extraction of the diseased tooth. Thus the cause of inflammation is removed, and the pus that may have collected in the bone obtains an outlet. The extraction is not difficult, as the tooth is only held in partially softened bone. It is then proper to prescribe the use of some emollient poultice, that absorption may be hastened, and the pain diminished. In from four to six days after extraction, as a rule, entire cure can be expected. If the skin is red and glossy, indicating an advanced stage of the abscess, it may be necessary sometimes to lance the abscess on the day after the extraction. The introduction of a drainage tube is not necessary, since under an antiseptic application the abscess heals in a few days.

If pus discharges into the mouth at this time, a mouth-wash of corrosive sublimate, 1 to 3000, may be used, and any portions of exfoliated bone that may be present should be removed as soon as possible.

If a fistula has already opened on the skin externally, the extraction of the abscessed tooth is a most important therapeutic precaution. After the extraction, the formation of pus ceases and the fistula gradually heals. It is only necessary to wash the diseased passage daily with some antiseptic wash. The cure will be proportionately slower after extraction the longer the fistula has existed. In order to hasten healing of the parts by granulation, it is best to syringe them with cauterizing liquids, or to cauterize with nitrate of silver. In about two hundred cases of dental fistula, that I have treated, I did not find it necessary to employ such remedies. In long passages extending to the neck or around the breast it is generally necessary to open the channel partially, and to inject irritating cauterizing fluids. If the skin surrounding the opening of the fistula

is degenerated, it should be cut away or scraped off with the sharp spoon.

Fistulæ always heal with marked cicatrization, and the skin is drawn tightly to the jaw, resulting in a disfiguring contraction, or scar. To remedy this disfigurement, Prof. Sauer recommends a small plastic operation. About 1 cm. from the cicatrix, on each side, an incision is made in the skin as represented in Fig. 20. From both of these incisions the skin is lifted and brought toward the wound. At this point the margins of the skin are fastened together with ligatures, leaving a space where the incision was made, which results in the appearance as shown in Fig. 21.



FIG. 20.

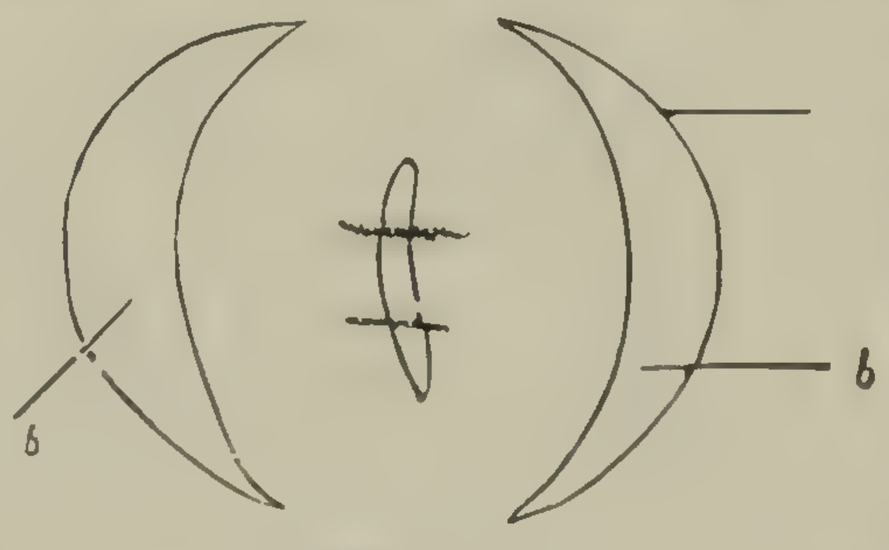


FIG. 21.

Incisions for the correction of cicatrices on the face.

The defects heal readily and leave scars but little noticeable.

Fistulæ resulting from non-carious teeth.—In most instances fistulæ are produced as hitherto described. Infection from a carious tooth leads to osteo-periostitis of the jaw. This in turn results in sub-periosteal abscess of the jaw, and after the abscess is opened, a fistula remains. If a tooth from which such a fistula has originated is extracted, the apex of the root will be found roughened; this was undoubtedly caused by the macerating influence of the exudate. But such maceration cannot take place in a tooth in which nutrition is in progress. The fistulous tooth must be necrotic, at least at its apex. The necrosis of the root, which is the result of the degeneration of the root-membrane, seems to be the prominent cause of the continuance of the fistula, which in turn resulted from an inflammation leading to abscess and caused by infection from the tooth.

But if the inflammation is not caused by infection from a carious tooth, but has resulted from some other cause, it is nevertheless possible that in the vicinity of the root of a tooth, whether it be carious or not, exudate may cause such pressure on the small vessels entering the tooth that its pulp may die, and portions of its root-membrane become destroyed. Thus necrosis of the apex of the root of a non-carious tooth originates, and this necrosis, if the inflamma-

tion has led to the formation of a fistula, may keep up a flow of pus from it.

[In the examination of this class of cases it should always be remembered that the pulps of perfectly sound teeth die from causes entirely unknown to the patient or physician, and show no sign. The roots of these teeth may be the seat of abscess the same as those with a carious cavity. In any case in which the symptoms point to a particular tooth as the probable cause of abscess, and this is not decayed, the fact as to whether or not the pulp is living should be ascertained by the temperature test.]

Such cases occur especially on the lower third molars, in which the inflammation is caused by difficult eruption, leading to irritation of the gums, from which the inflammation is extended to the periosteum of the jaw and to the jaw itself. In two cases in the surgical polyclinic, trauma was the cause of an ostitis and the formation of a fistula; the fistula existed for a number of years, but healed readily after the extraction of an apparently healthy tooth, whose pulp was destroyed by soft gangrene, and whose root-membrane had decomposed and formed pus. I once saw such a fistula in the case of a man who a few years previously had the typhoid fever. In this case the inflammation of the jaw resulted from typhoid stomatitis. The pulp and periosteum of the tooth had been destroyed.

In such cases it is sometimes difficult to find out the proper tooth, as it does not differ externally from the other teeth, and the line of the fistula is not always distinct. Very slight indications of chronic periostitis, and occasionally a somewhat less livid appearance of the tooth, must be the principal factors of diagnosis.

Empyema of the Antrum of Highmore.

From the upper molars, less frequently from the bicuspids, the inflammation of the bone caused by the septic decomposition of the pulps of these teeth sometimes extends to the antrum of Highmore. The latter is separated only by a very thin lamella of bone from the apices of the molars, and this thin layer is almost always involved in inflammation, in alveolar periostitis. Less frequently does this inflammation extend to the mucous membrane of the antrum to any great extent, and still less frequently does an abscess of the alveolar process penetrate this membrane and discharge the pus into the antrum. If inflammation of the mucous membrane

does take place, the natural opening between the antrum and the nose becomes diminished by the swelling of the mucous membrane to such an extent that the exudate cannot escape. By the stagnation of the exudate in a cavity filled with atmospheric air the inflammation of the carious borders of the cavity becomes excessive, and a large collection of pus takes place within it. Its walls become distended, and the anterior or facial wall especially protrudes; the hard palate is asymmetrical, and is less vaulted on the affected side. The nasal wall may be so far distended as to close the nares. The distention of the walls of the orbit may cause compression of the eye-ball and exophthalmos.

The patient occasionally suffers severe pain from irritation of the superior dental nerve, which is lodged in the bony canal, or which is sometimes covered only by the mucous membrane, and passes along a groove in the base of the cavity. Inflammation of the bony walls follows, whereby they become softened until at one or more points the pus breaks through and establishes fistulæ. These are found most frequently in the canine fossa, but pus may also enter the mouth alongside the tooth. The discharge of pus through the tuberosity into the pterygo-palatine fossa is more dangerous, since from here it may find ready entrance into the base of the cranial cavity.

The larger number of cases do not form fistulæ. Generally there is sufficient outlet through the nose, so that the symptoms do not become very troublesome. The discharge of pus then becomes chronic, and inconveniences the patient only by the bad odor.

Aside from alveolar periostitis, inflammation of the antrum may occur from injury, by being entered, as may be the case, in the extraction of a tooth, or by the extension of inflammation from the mucous membrane of the nose. The chronic course is similar to that of catarrh of the nasal mucous membrane.

In the treatment of inflammation of the antrum of Highmore, it should first be observed that the normal connection with the nose has been maintained. If the opening is closed, a new one may be made in the nose, with a trocar. Cases that have their origin in alveolar abscess are also treated by the extraction of the affected tooth. From the alveolus of the tooth the floor of the antrum can be readily perforated, either with a trocar or the dental engine. The cavity may be now cleansed by syringing it with a solution of

corrosive sublimate, 1 to 3,000, or carbolic acid, 1 to 100, four or five times a day. Iodoform blown into the cavity has also a very good effect. In order to prevent particles of food from entering the cavity a plate may be worn while eating; a small plate covering the opening and attached to the adjoining teeth answers the purpose.

The extraction of a diseased tooth, and the perforation of the floor of the cavity for the purpose of securing an opening is also recommended, even if the tooth is not the cause of empyema. If a number of diseased teeth are present, the first molar is generally selected and the socket opened through the anterior buccal root. If all the teeth are healthy the opening can be made preferably from the mouth immediately above the first molar.

Not every injury of the floor of the antrum leads to inflammation. If, for instance, after the extraction of a tooth on the root of which, as I have observed, there may be a mass of granulations, an opening should occur, the patient will discover that himself, as in rinsing the mouth with water the blood and water will pass through the nostrils at the same time; this nevertheless need not lead to inflammation of the antrum. A gutta-percha tampon should be placed in the wound immediately, and by being held in place by the adjoining tooth, the opening will be protected from external injury. It generally heals in a few days, and the tampon may be removed.

Phosphorus Necrosis.

This disease is mentioned here only on account of its etiology. It is due to the action of phosphoric vapors on the periosteum of the jaw. As this, however, is covered by the gums, in a mouth kept perfectly clean and in which the gums and the teeth are entirely healthy phosphorus necrosis can scarcely occur. It is generally thought that carious teeth have a tendency to encourage phosphorus necrosis. The manner and means by which carious teeth aid the entrance of the poison into the organism are not very clearly understood.

It is possible that the phosphorus that gets into the tooth is carried into the pulp-chamber and the root-canal with the débris, after the decomposition of the pulp. With the débris the phosphorus and its combinations may reach the alveolus through the dental

foramen, in the same manner as the débris alone may cause alveolar or maxillary periostitis. In this manner there may be caused a periostitis of the jaw, which, in consequence of the incorporation of phosphorus, may lead to the peculiar symptoms of phosphorus necrosis.

Rachitis.

This general disease is briefly referred to here, as in a few cases there are very peculiar appearances in the maxillary bones. I have observed in several rachitic children, of from two to four years of age, how certain external entirely intact incisors and cuspids of the temporary teeth projected beyond the line of the remaining teeth to the extent of from 2 to 5 mm., and which at the same time were loose and painful. When the teeth were extracted, the roots were not found absorbed, but instead the unaltered roots were raised to some extent in the bone from multiple inflammations.

Chronic Abscess of Bone.

On the side of the lower jaw, and corresponding with the location of the molars, I have seen several times chronic swellings which were held to be cystic formations or chronic periostitis.

The swelling had been noticed by the patient for six or eight months, in one case two years, and was conical in shape, the demarcation was not plain, and it was not movable on the jaw. The skin covering it could be raised readily, and was not reddened. The tumor was hard to the touch, but not painful on pressure. In the mouth, corresponding with this position, there was a carious molar whose pulp was dead. The extraction of this tooth was followed by a copious flow of pus from the alveolus. The probe passed through the flow of the alveolus into a cavity of 2 to 3 cm. in depth. The succeeding days the cavity was syringed several times daily with carbolized water, and the swelling rapidly disappeared.

The origin of these chronic abscesses can be traced back to the influence of the septic contents of the molar teeth. When a small quantity of this passes through the dental foramen, an inflammation is established in the bone. The calcium salts are dissolved, the vessels in the marrow become more numerous, and the leucocytes infiltrate the marrow, which becomes richer in fats and is penetrated

by young cells. The continued septic influence of the tooth causes the young marrow to change into pus. During these processes the periosteum becomes thickened, and on the surface of the bone, which is irritated from the interior, osteophytes are formed. This causes the bone corresponding to the location of the abscess to become thickened, and gives it the appearance as if driven apart or inflated. A confusion between chronic bone abscess and cyst formation or chronic periostitis can readily occur. The wall of the cyst can generally be pressed in, for it is not very hard. From chronic periostitis bone-abscess can be readily differentiated by the shape of the swelling, which in the latter is decidedly conical.

Maxillary Cysts.

Cysts of the jaw are generally really dental cysts. They originate either from the root-membrane of a healthy or carious tooth, or from the follicle of a dental germ. They may be caused also by retained teeth, and in some cases may be traced back to cystic degenerations from odontomes. The most frequent are the cysts originating from the root-membrane, and which are located more in the alveolar process than in the jaw. Wedl discovered a few years ago (*Virchow's Archiv*, vol. 85, No. 1, 1881) in the dental periosteum of an injected preparation, even with the hand-lens, recognizable vessels or canals which were similar to those of the kidneys, covered by a tender capsule of connective tissue. [It is probable that these were in fact the lymphatics of the peridental membrane. I can readily understand how such an error might occur to any one who had not previously made out these lymphatics.] From this capsule possibly most of those alveolar cysts that are in connection with the dental periosteum are developed.

These cysts cause a swelling on the outer surface of the jaw and alveolar process, whose walls at the beginning still contain some bone substance, but this gradually becomes thinner and more porous during the enlargement, so that it will yield to pressure (crackling like parchment). In some places the bone-wall has disappeared entirely, and fluctuation may be felt.

The mucous membrane covering the cyst is somewhat hyperæmic from stasis. Such cysts occur more frequently on the upper than the lower jaw. They take their origin more often from the bicuspids than from any other group. In the lower jaw these cysts

readily form in the body of the jaw, and in these cases the diminished thickness of the bone-wall cannot be readily distinguished through the skin. In the upper jaw, on the other hand, the swelling increases more in the region of the alveolar process, so that it can be readily examined from the mouth. Less frequently in the upper jaw the swelling extends farther up into the body of the jaw. In this position it becomes enlarged at the expense of the space of the antrum. The latter, however, remains separated from the space of the cyst by its mucous membrane, which bulges inward, and by the sac of the cyst, which is in contact with the mucous membrane. About the time that the patient seeks relief, the cyst is usually the size of a walnut, and it has been noticed perhaps for six months or more. If left to itself, occasionally inflammation of the cyst will take place as a result of injury to which the thin wall is exposed within the mouth. The otherwise slimy or serous contents become changed into pus and are discharged into the oral cavity. After the contents have escaped, the cyst again becomes filled with pus and saliva; particles of food and bacteria also find their way into it, and the contents become ichorous and malodorous. If the difficulty has been neglected up to this time, the patient seeks relief on account of bad taste and a disagreeable odor from the mouth.

In the extraction of teeth from whose root-membrane cysts have originated, occasionally a large part of the cyst-sac remains attached to the root. Sometimes the firm union of the root with the cyst makes extraction difficult. The root often escapes from the forceps in the effort to extract it, and it sometimes happens that after several attempts it suddenly disappears within the cavity of the cyst. The elasticity of the sac, which is somewhat stretched during the attempts at extraction, is increased, and the root is thus drawn into the cavity when the forceps slips off. The root appears again, when the cavity of the cyst has gradually diminished in size. Cysts originating from retained teeth are more frequent in the lower jaw, and attain a much larger size. In the floor of these cysts there may be felt, with the probe, one or more of these teeth, whose covering of enamel is readily detected by percussion.

An unusually large size is attained by those cysts of the lower jaw that originate from dental follicles, they sometimes changing the entire lower jaw into a large swelling, and remain for ten years or more. Cases have been observed in which traumata were the

predisposing cause of cystic development of the second and third molar germ of the lower jaw.

Those cysts that are due to the degeneration of odontomes, contain in the sero-mucous contents a larger or smaller number of diminutive partially developed teeth, the products of partly dentified odontomes. In other respects the appearances of a cyst are presented, in which, as a general rule, on the corresponding side of the jaw one or more teeth are absent. If this is not the case, a supernumary dental germ may have given origin to the cyst or odontome.

The treatment of the smaller cysts that originate from the dental periosteum commences with the extraction of the tooth in question. The tooth, as a rule, is carious, and is generally only a root. There are cases, however, in which the development of the cyst proceeds from the periosteum of a healthy tooth. I have observed such a case, which had its origin from a temporary tooth.*

After the extraction of the tooth, as a rule, the contents of the cyst are evacuated spontaneously through the alveolus, and sometimes a part of the sac remains attached to the root. In a few cases I have brought away the entire cyst with the tooth. If no part of the cyst remains attached to the root, and the contents do not escape after the extraction, it may be considered as possible that an adjoining tooth is the origin of the cyst.

The further treatment consists in preventing septic decomposition within the cavity of the cyst. This may be done by syringing the cavity from three to five times daily with 1 per cent. carbolized water, or a 1 to 5000 solution of corrosive sublimate. The cavity is then closed by the approach of the various walls toward one another, for the bone grows in the direction of least resistance. With this treatment it always takes from three to six months for an alveolar cyst to close entirely. If a part of a sac of the cyst be removed in the extraction of the tooth, cure is more rapid. In these cases granulations put out from the exposed Haversian canals, and these ossify later on. Healing takes place in the same way after complete destruction of the sac. For the purpose of destroying the sac, cauterants are employed; these however at the same time lead to pus formation. In about thirty-five cases of cysts that I have had the opportunity of treating, I have relied on antiseptic washes, which

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*See *Zahnärztl. Mitth.*, page 98.

the patient could employ himself during several months; I have always observed closure of the cyst cavity.

Cysts due to retained teeth are treated by the removal of a part of the cyst-wall, after which the treatment is continued in the same manner as just described. Cysts that embrace the greater portion of the lower jaw require resection of the jaw. Cystic degenerated odontomes, etc., also require partial resection.

If a cyst is inflamed, and the contents have become purulent and ruptured, antiseptic treatment is to be carried out as after the extraction of a tooth projecting into a cyst, or after excision of a portion of the cyst-wall.

Cysts in the antrum that do not originate from teeth but from mucous glands, are not opened by the extraction of a tooth, but can be easily reached artificially from the alveolus of a tooth, and then treated.

Fractures of the Maxillæ.

Fractures of the jaw occur most frequently in war as gun-shot fractures. At other times they occur by concussion with the dash-board of vehicles, or the kick from a hoof, falling from a height, etc.

Fractures of the lower jaw are readily recognized, if the examination be made from within the mouth. The pain that the patient experiences during mastication, and an inflamed swelling at the affected point, will cause the physician, in case of trauma, to examine the jaw for the purpose of ascertaining whether there is a fracture.

The mobility of the fractured portions is observed by the patient himself, and is also objectively shown if pressure is applied to the teeth or the alveolar process at the site of pain. The regularity of the dental arch is altered. This symptom, however, is not always very clear. In cases of fracture at the median line of the jaw it is entirely wanting, because the contraction of the muscles is equal on both sides. In fractures in the vicinity of the cuspids the lateral portion of the fractured jaw is raised somewhat and drawn backwards. This change is slight, however, if the soft tissues are not badly lacerated. Occasionally in fractures in the vicinity of the bicuspids there is no dislocation whatever. Farther back, as a rule, only the vertical dislocation is to be observed, as, for instance, when the point of fracture is between the second and

third molars, the latter may be raised from 2 to 5 mm. higher than its neighbor. This is not marked if the second molar has been destroyed by caries, so that the third stands isolated.

Fracture of the ramus of the jaw is less frequent than that of the body. It is more difficult of diagnosis, as the upper portion of the bone cannot be grasped with the fingers.

Crepitation is easily made out in the locality of the teeth within the first eight days after fracture. At a later stage it is absent on account of the formation of granulations, and of the partial ossification of the fractured ends. In fractures of the ramus crepitation is very difficult to make out.

In fractures of the lower jaw, as a general rule, the gums are lacerated at the point of fracture. Nevertheless, this injury does not exert the unfavorable influence upon subsequent healing, as is generally the case when the integuments are lacerated at the sites of fracture. Only those cases in which the skin is also lacerated, and in which the fracture is complicated, may be considered as difficult cases.

Compound fractures occur in the most varied manner. Thus, for instance, in a case that occurred in my practice one point of fracture was at the right third molar and the other between the left cuspid and first bicuspid (caused by concussion of the chin against the dash-board of a wagon); in another case the bone was fractured between the central and lateral incisors of the right side, and between the same teeth on the left side; this injury was the result of a fall from a height of sixty feet.

Comminuted fractures generally lead to the formation of abscess, fistulæ, and necrotic exfoliation of the splinters.

Healing of the parts is accomplished by nature, with a displacement and a pseudarthrosis, in uncomplicated fractures, in from three to six months. When proper treatment is employed, and in recent cases, a cure is effected, without dislocation and by callus-formation, in from three to six weeks, according to the age of the patient; correspondingly more rapidly than in fractures of the extremities on account of the great vascularity of the bones of the face. Complicated fractures require three times as long a period, and old neglected cases sometimes baffle treatment for a long time. Fractures of the coronoid process heal by pseudarthrosis, as the fractured pieces cannot be fixed to each other. Occasionally the force causing the

fracture also causes paralysis of the inferior dental nerve, but this gradually recovers.

Treatment of fractures.—We pass on without describing the older methods and bandages, such as the Funda maxillæ, capistrum duplex, etc., and will only describe briefly the firm bandages that are applied to the teeth.

It is not feasible to bring the fractured ends together by ligatures of either strong silk or thin metallic wires, applied to neighboring teeth, because these loosen the teeth. Even if two or three teeth on each side are included in the ligature it is impossible to avoid loosening the teeth. As a secondary bandage these ligatures may be employed, when, in cases of slight lateral displacement of the fractured portions, the bone suture is employed. With this combination, which causes the patient but slight inconvenience, sufficient retention can be often secured.

The caoutchouc and gutta-percha splint described by Haun,* which was used by its inventor with good results during the war of 1866, was made as follows: After the ends of the fracture are brought into their proper position, they are held so for a time by tightly drawn bandages. An external impression of the lower jaw is then taken with plaster-of-paris, all injuries of the skin having been first protected. This impression, after it has hardened, answers the purpose only of retaining the jaw in its proper position until an impression of the teeth and the alveolar process can be taken. This is done in the same manner as for the manufacture of artificial teeth. From this impression a cast is made of the fractured portions of the jaw, which includes the teeth and the alveolar processes. From this cast a splint of hard rubber is made, which covers all the teeth, and that portion of the alveolar border covered by the gum as far down as the point of the attachment of muscles. This cap should not fit very closely, so that it may be lined with gutta-percha. At the point of injury the lateral walls of the splint are cut out to near its horizontal portion. Through the horizontal portion a hole should be bored to correspond with each tooth. Before applying the splint to the teeth it is covered with a thin layer of softened gutta-percha, and when it is placed in position, the gutta-percha escapes through the holes, so that when the mouth is closed an impression of the upper

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**Vierteljahrsschr. f. Zahnh.*, 1867.

teeth is made in it. When the splint is properly pressed the jaw is fastened with a four-tailed bandage for a few hours, or until the next day, firmly against the upper jaw; the splint is then immovable, and will prevent movement of the fractured ends. Süersen's caoutchouc splint,* which was frequently employed during the war of 1870–71, differs from that of Haun in the method of obtaining the impression of the teeth, without the use of gutta-percha. The impression is taken simply from the fractured jaw in the position in which it is, without having first been replaced. A cast having been made from this impression, it is divided at the point of fracture, and articulated in its proper position to a cast of the upper jaw, in such a manner that the teeth of the lower jaw will articulate with those of the upper in their normal position. On a corrected cast thus prepared, a hard-rubber splint is made in such a manner that it covers all the teeth, leaving the masticating surfaces free. This is possible only in those cases in which there is a space left by the extraction of teeth on both sides, at which point the labial and lingual portions of this splint are united. Where no such spaces are present the horizontal part of the splint must remain united excepting at some points where the incisive edges may be allowed to protrude. Such a splint will hold the fractured ends in proper position provided the case is a recent one. If, however, firm callus has formed, and if the muscular contraction is powerful, the dislocated end of the fractured jaw will slip out from the rubber splint, as I have observed in a few cases. For such old cases Süersen used a separate splint for each fractured portion, and endeavored to bring the dislocated parts gradually into their natural position by placing between both portions a piece of hard wood, whose ends were fastened in properly located holes within the splint. The pieces of wood were from time to time (every two or three days) replaced by longer ones, until the fractured ends of the bone came in contact with each other. In a similar manner he treated such cases of fracture of the jaw in which, by a gun-shot wound, a portion of the bone was entirely torn away. If, for instance, that part of the lower jaw corresponding to the incisor teeth was entirely torn away, the two ends were drawn inward. With wooden wedges the fractured parts of the jaw were extended gradually, until they articulated

**Vierteljahrsschr. f. Zahnh.* 1871.

properly with the upper teeth. The remaining defect can be remedied by an artificial denture, which at the same time serves the purpose of retaining the fractured parts in their proper position.

Sauer's wire splint* is certainly far preferable to all others for old cases, and even for recent cases it offers several advantages.

An impression is taken in the same manner as for Süersen's caoutchouc splint, and a cast is made in the same way, one which will articulate properly with the model of the upper jaw. To fit this corrected cast, a tinned iron wire the thickness of a knitting-needle is bent to correspond with the circle of the teeth, or a gold wire may be used. One end of this wire begins at the point of fracture on the lingual side of the teeth; then it is carried around the last molar on the same side, bent at that point, and brought back on the labial side of the teeth to the point of fracture, where it ends. Another piece of wire begins also at the point of fracture on the labial side, and is carried around the last tooth and brought back on the lingual side of the teeth to the fracture, and extends two or three teeth beyond it. (See Figs. 22 and 23.)

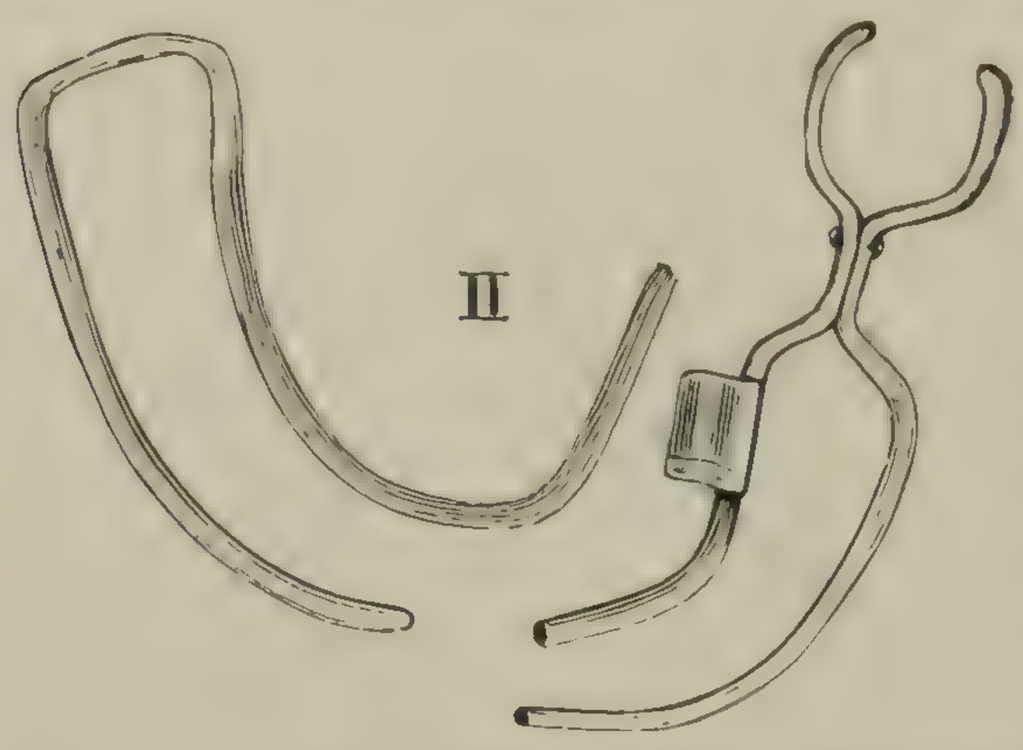


FIG. 22.—*Sauer's Wire Splint, separated.*

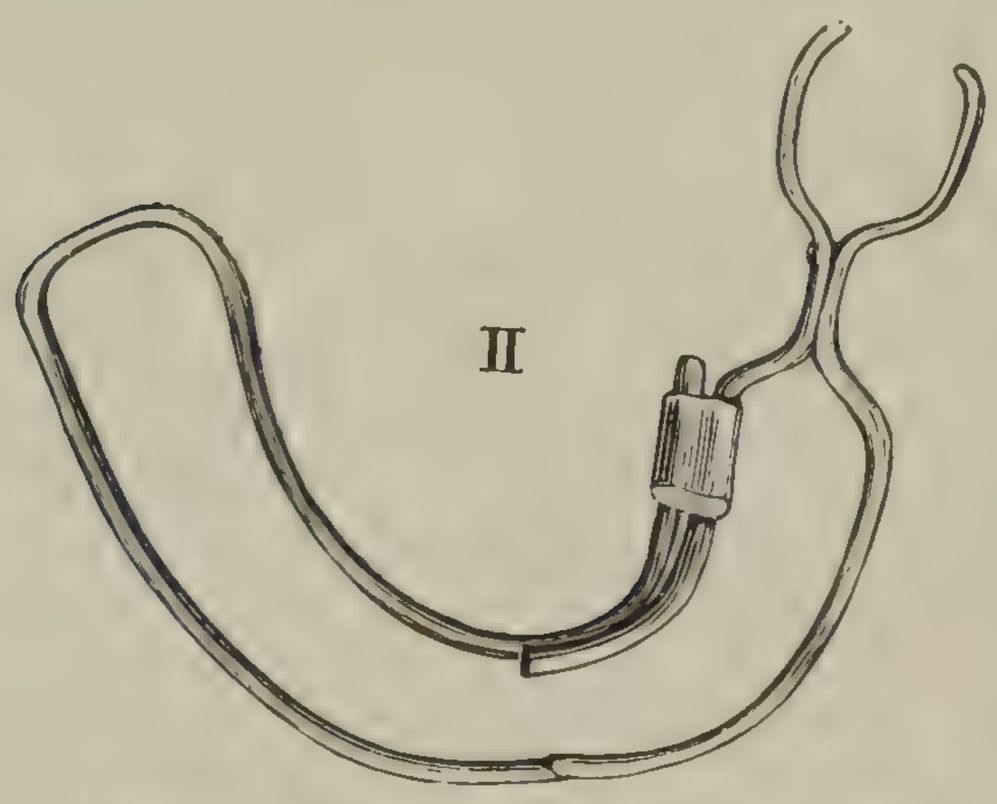


FIG. 23.—*Sauer's Wire Splint, closed.*

If on either side there is a space caused by the extraction of teeth the wire may be strengthened by solder, or riveted together and extended in the form of a clamp around the last tooth. To the lingual side of the shorter piece of wire, corresponding to the fracture, a collar is attached, through which is passed the free end of the opposite wire, which extends beyond the fracture.

This wire splint is placed upon the teeth, and its lingual portion

*Comp. *Vierteljahrsschr. f. Zahnh.* 1881.

connected with its labial by binding wires between alternate teeth (See Fig. 24). In proportion as the callus is absorbed and the muscular opposition overcome, the labial and lingual portions of the splint are brought more closely together by tightening the wire, thus exerting a pressure upon the teeth of the dislocated portion of the jaw, which is finally brought into its normal position. Sauer's splint has under all circumstances the advantage over the others in that it permits of a more thorough cleansing of the mouth and the gums.

Again must I refer to the greater difficulty of correcting old cases. It cannot be too urgently recommended that in cases of fracture of the jaw a proper splint should be applied at the earliest possible moment. In recent cases it is astonishing how rapidly an entire cure is effected. As an illustration I cite the following case from my practice:

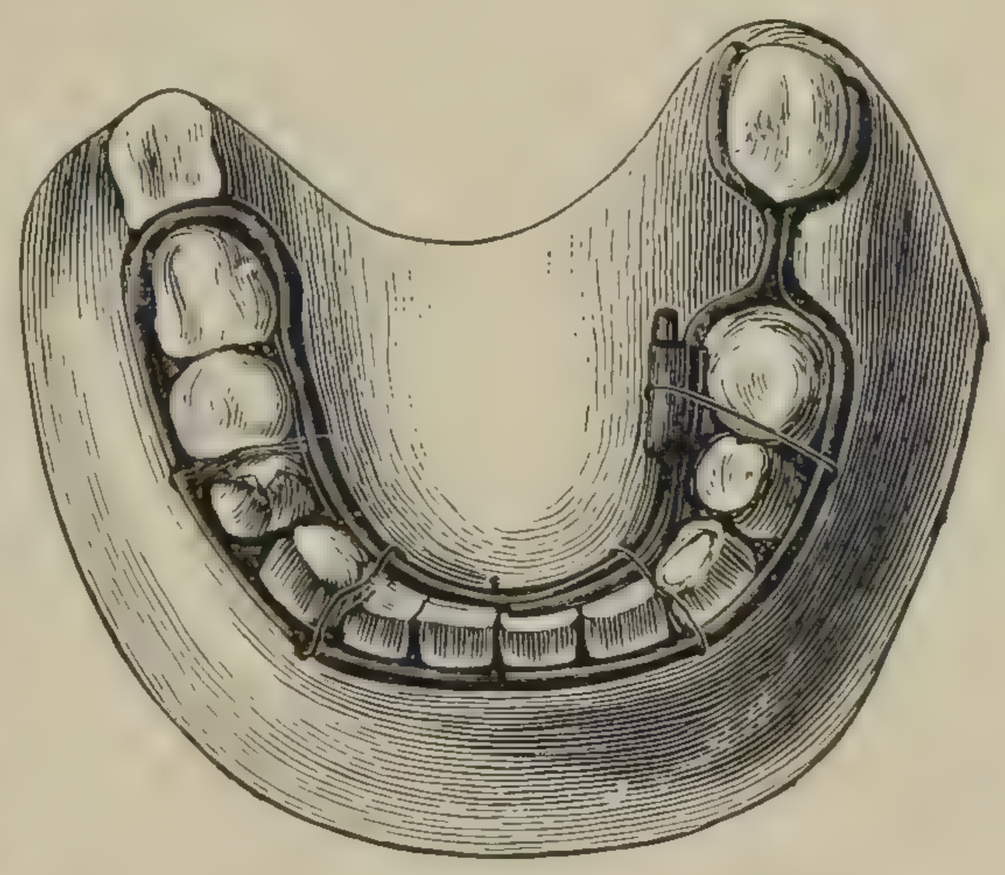


FIG. 24.—*Sauer's Wire Splint, in situ.*

A workman, thirty-five years of age, received a compound fracture by concussion with the dash-board of a wagon, on March 7th, 1881. The site of fracture on the right side corresponded with the space left by the extraction of the second molar, and on the left side it was between the cuspid and the first bicuspid. The latter was drawn backward and inward, while on the right side there was but slight displacement. At both points there was slight laceration of the gums and slight swelling. On March 9th an impression was taken, and the following day a splint of hard-rubber applied. On the 11th the patient was tolerably well satisfied with his condition; before the application of the splint the fractured ends were painful on the slightest motion. After firm fixation of the parts, movement was prevented and the pain disappeared. On March 23d, twelve days after the application of the splint, and fifteen days after the injury was sustained, the splint was permanently removed. Although there was still some swelling, the patient was nevertheless able to masticate soft substances without the splint. On April 13th, five weeks

after the injury, the patient attempted the mastication of bread crust for the first time. On the chin where the dash-board struck, there was still partial paralysis, and the incisors seemed to have lost sensation.

If, in this case, instead of applying the splint three days after the injury it had not been applied for three weeks, the rubber splint would have hardly served the purpose, the dislocated portion would have slipped from the splint continually. Sauer's splint could have been employed, and a favorable result brought about, but it may have been necessary for the patient to wear the splint for from eight to twelve weeks.

[In one case to which I was called, the lower jaw was broken at the angle, and between the bisuspids, on the left side, between the lateral incisor and cuspid, and between the first and second molars on the right, and was complicated with several openings through the skin. This was the result of a blow from an iron pulley which suddenly broke away from its fastenings under a heavy strain.

In this case the piece containing the molar and bicuspids on the right side turned inward in such a way that the crowns of the teeth pointed toward the tongue; the piece containing the molars on the left was much displaced outward at its anterior end, and that containing the incisors was drawn back between the other two. The person was very fat, and when I saw him two days after the accident, there was great swelling and the face was terribly distorted. The case presented grave difficulties, especially as it was far from any laboratory. The treatment was begun by so straightening up the piece on the right side that an impression of the crowns of the teeth could be had; then this was taken in impression wax without other regard to the position of the several pieces. The model made from this impression was divided at the points of fracture and corrected. When this was satisfactory, a single thickness of gutta-percha base-plate was made warm and accurately moulded to the teeth with the fingers. Then an ordinary iron wire, a little thicker than a heavy knitting-needle, was cut and bent to the proper shape, and laid (warm) along both the buccal and lingual sides of the teeth, and another thickness of gutta-percha base-plate well warmed was moulded on over these, passing over the crowns of the teeth all the way around the arch. When all was cold and hard it was removed from the model and trimmed, so that it should not injure the soft

parts. Now, as a preparation for adjusting this splint, a strong ligature, and a large sized platinum wire was passed around each of the three anterior fractured pieces of the bone, at two points, and one at the angle of the jaw on the right side. These were put in place by passing a needle into the floor of the mouth close to the lingual side of the bone, down under the bone, and out on the face. This, with the same thread, was now passed back to the bone by the same hole in the soft tissues, and then brought up into the mouth on the outer or buccal side of the bone. With this thread the platinum wire and the ligatures were drawn into place. When all of these were in place they were so disposed of as not to be tangled up in adjusting the splint. This was now placed in position and the teeth of the posterior fragment on the left side forced into their places, and the splint tied down upon them. Next the ligature at the right angle was tied upon the splint. Then the loose piece upon the right side was got partly into place with some difficulty, and tied temporarily. Finally, the anterior piece containing the incisors was pulled forward, and the teeth made to enter the splint. After this the ligatures were tightened one after another until all of the teeth had gone firmly up to their places in the splint. Now when all seemed satisfactory, the platinum wires were secured over the splint and made tight. The ligatures were allowed to remain a few hours for the purpose of seeing that everything was firm, and finding it so, these were removed and only the platinum wires were left to hold the splint in place. The ligatures were used in the first instance, because they were readily tied and again loosened in pulling this piece or that in getting them into place, while the wire might be broken. They were removed when this work was accomplished, because they were more likely to keep up suppuration than the wires. The external wounds were finally cared for, and the chin supported as well as was practicable with bandages. The case made a good recovery, and without deformity, except some scars from the flesh wounds.

This plan of passing ligatures, or wires, one or both, around the lower maxilla in cases of fracture is to be recommended only for cases that present unusual difficulty. But when other means seem likely not to prove efficient it should be unhesitatingly undertaken. The only point of danger is injury to the facial artery, which should be carefully guarded against.

The surgery of the lower jaw is, all in all, the most troublesome with which the general practitioner has to contend. This is true largely for the reason that he is so likely to begin by the use of plans that prove inefficient, rather than from the real difficulties of the case. A simple, single fracture, if not in the region of the bicuspids, may be held by very simple means, usually by a well-adjusted bandage over a gutta-percha or plaster-of-paris shoe properly fitted to the chin while the parts are held in apposition. Fractures at the angle of the jaw are usually held very nearly in position by the strong attachments of the pterygoid and masseter muscles; but if it be a little forward of the angle, this side of the jaw, the anterior portion of it, will not come up to place, and must be supported from below, or, as I have done in one case, the lower teeth may be firmly wired to the upper. Indeed, this latter plan is very efficient, and I should have made much use of it but for a feeling of danger in case of a violent fit of vomiting. However, if the patient has had no solid food for some hours, he is not likely to eat anything afterward that would not pass out through the interstices between the teeth. In fractures anterior to the attachment of the masseter muscles and posterior to the muscles attached anteriorly in which much displacement has occurred, i.e., in which the periosteum and gums have been lacerated, some of the forms of interdental splint should be used. The particular plan to be employed in any case must be determined by the ingenuity of the surgeon, in each individual case, after a study of the displacement and the pull of the muscles upon the fragments.]

Fractures of the upper jaw are less difficult of treatment than those of the lower jaw, since muscular contraction is no factor in dislocating the fractured portions. In recent cases a simple replacement of the parts is necessary, and for aiding a more rapid cure the application of a simple retention splint may be employed. In older cases the deformity may be remedied by the use of spring-wire which will exert a constant pressure.

Dislocation of the Inferior Maxilla.

Luxation may take place if the mouth is open to such an extent that the condyloid process (with the intervening cartilage) passes in front of the line of action of the masseter muscles. It may occur during mastication, yawning, and sometimes during operations on

the teeth. The capitulum passes in front of the articular tubercle, upon which it always passes when the mouth is opened, and in front of it into the temporal fossa. The capsular ligament is not ruptured, because it is very tenacious and large. Dislocation of the jaw is readily diagnosticated. The patient cannot close the mouth, mastication is impossible, saliva flows from the mouth, and speech is indistinct. A digital examination reveals immediately anterior to the ear a concavity, which is usually filled by the capitulum.

Replacement is very easy. Pressure is applied on both sides with the thumb in the region of the molar teeth of the lower jaw, perpendicularly downward, in order that the head of the condyle may be again brought upon the articular tubercle. When this is accomplished the anterior portion of the jaw is slightly raised, which results in sliding the capitulum backward into the condyloid fossa; but that the fingers may not be injured by being bitten, it is best to wrap them in napkins. After correcting the dislocation the patient is recommended to bandage the lower jaw against the upper, and to take care for several weeks not to open the mouth too far, as the disposition to a recurrence is great.

Neglected dislocation of the lower jaw is very rare, as the patients are exceedingly annoyed by the arrest of the functions of the lower jaw, are generally frightened at the inability to close the mouth, and hence promptly seek relief.

Serous Inflammation of the Temporo-Maxillary Articulation.

Of the diseases of this articulation only that of serous inflammation is herein referred to, because a superficial examination may cause it to be confounded with inflammation of the jaw, which may have resulted from affections of the teeth.

The patient simply complains of pain on one side during mastication. As such complaint is very frequently made when there is some derangement of the teeth, and as inflammation of this joint or articulation is infrequent, one may be led to examine only the teeth and leave the joint unexamined. If there is no gingivitis, periostitis alveolaris or maxillaris, or dentitio difficilis present, an inflammation of the temporo-maxillary articulation may be surmised. A comparison of the diseased side of the face with that of the healthy will reveal a diffuse swelling, which may be sensitive to pressure, in the vicinity of the joint below the zygomatic temporal

bone. If the mouth is frequently opened and closed while the finger is held against the condyloid process, an occasional jarring may be felt.

Treatment is confined to rest, painting with tincture of iodine and the application of ice-water compresses. For the purpose of securing rest for the joint, the patient should subsist on liquid food and soft substances only, and also wear a bandage on the lower jaw. This treatment is followed by the disappearance of the inflammation in from five to six days, as a general rule.

CHAPTER VIII.

DISEASES OF THE MUCOUS MEMBRANE OF THE MOUTH.

In this chapter will be considered principally those affections of the gums and the oral mucous membrane that originate from affections of the teeth, or that are related to them in some other way.

Hyperæmia of the Gums.

The normal gum is of a bright rose-red color and is firmly attached to the bone. In general anæmia it is, as other mucous membranes, pale, and in persons affected with heart disease, and some of the pulmonary diseases, it has a bluish-red appearance, which is due to passive hyperæmia.

The gums are in a congestive hyperæmic condition in the case of children during difficult teething, as well as in adults during difficult eruption of the third molars.

The gums are also chronically hyperæmic in persons that do not use the tooth-brush daily. A dirty deposit takes place on the teeth, consisting of thickened mucus, particles of food, epithelial cells and numerous micro-organisms. This deposit cannot take place readily on the lingual surfaces of the teeth, because the tongue prevents it by its motion and the friction it causes. From the incisive and masticating surfaces it is also necessarily removed, but the friction caused by our artifically prepared and softened food is too slight to remove it from the labial, buccal and the proximal surfaces of the teeth. Near the neck of the tooth, adjoining the gum, this deposit is extensive, and is continually undergoing acid fermentation and decomposition. This leads, in the case of soft teeth, to caries, as we have already observed; but it also causes an irritation of the gums, so that they assume a dark red color around the necks of the teeth, and become swollen. The inter-dental papillæ, especially, are loose, spongy, and bleed readily. In some

persons, especially in drinkers and incessant smokers, the chronic hyperæmic condition extends through the entire gum.

Chronic hyperæmia of the gums is also aided by decomposing particles of food, the contents of which not only mingle with the food, but are also pressed upon the gums during mastication. Not infrequently we see only a row of decayed roots as the remnant of a denture, and a number of these may have fistulæ, or be in a chronic periostitic condition.

A further cause of chronic hyperæmia of the gums is the wearing of artificial dentures, because the suction of the plate causes a dilatation of the smallest vessels of the gum. Nevertheless, this hyperæmia may be maintained at its minimum by proper care of the plate and of the remaining natural teeth; and sometimes it may even cause an anæmia of the mucous membrane of the gum, at least at the points where a certain equal pressure is exerted, as for instance at the posterior border of the plate. In order to prevent hyperæmia of the gums under artificial dentures: 1, there should be no decayed roots under it; 2, the dentures should be polished on the side facing the gum the same as on the lingual side; 3, the plate should be kept continually perfectly clean, so that no particles of saliva or food, dead epithelial cells and micro-organisms can be retained between the plate and mucous membrane until fermentation has set in; 4, it it advisable to remove the teeth during the night for the purpose of permitting a return to natural conditions of the parts that have undergone change during the day.

One of the most frequent causes of chronic hyperæmia of the gums is the accumulation of tartar on the teeth. This consists principally of phosphate and carbonate of lime, epithelial cells, particles of food, saliva, micro-organisms, etc. The combinations of lime are deposits from the saliva, which contains phosphate and carbonate of lime in solution, but which salts are separated by evaporation in the air, by the giving off of carbonic acid gas, etc. Hence tartar accumulates principally on those teeth near which the larger salivary glands discharge their secretion, and these are the lower incisors and the upper first molars. The accumulation of tartar commences at the neck of the tooth under the border of the gum, and causes incrustation of such portions of the crowns as are not in friction during mastication. In atrophy of the alveolar process the exposed roots are also incrusted. On the lower incisors in some persons the

tartar seems to hasten atrophy of the alveolar process. It appears as though the voluminous deposit exerted the effect of causing atrophy of the gum. On the upper incisors small crusts of tartar are found only immediately under the free margin of the gum. The labial surfaces frequently appear greenish-gray in consequence of fungoid vegetation. Daily brushing of the teeth will keep the accumulation of tartar at a minimum, but the deposition cannot be prevented entirely on the lingual side, even if the greatest care is exercised. The greenish-gray deposit on the upper incisors does not take place, however, when regular cleansing is resorted to.

As the accumulation of tartar occasions and maintains a hyperæmic condition of the gums, and as it gives a disagreeable odor to the breath, and is unpleasant to the patient, it must be removed from time to time by the dentist. For this purpose there is an assortment of sharp instruments whose points are passed beneath the border of the gum and beyond the margin of the deposit, whence it is removed by a sudden quick motion, after which the lingual and labial surfaces of the crown should be thoroughly scraped. Finally, the under surface of the crown is polished perfectly with a soft-wood pencil and rubber-disks, and pulverized pumice stone. During these operations the hyperæmic gums will bleed in various places, —a matter that is of no consequence.



FIG. 25.
Instruments for removing Salivary Calculus.

The patient should be advised to cleanse the teeth thoroughly at least twice a day after the employment of such a course of treatment. Hyperæmia of the gums is generally cured in from four to five days.

GINGIVITIS AND STOMATITIS.

If the causes of hyperæmia of the gums operate more intensely, or if several such causes are exerting their influence at the same time, and when a certain predisposition to inflammation exists, there

may arise inflammation of the gums, gingivitis or ulitis. Predisposing causes are, among others, psychical depressions in women during the periods of menstruation and pregnancy. There seem to be also certain miasmatic influences that cause inflammation of the gums, for not infrequently such cases become more numerous in practice for the time being.

As an accompaniment with diseases affecting the entire system (typhoid, etc.). gingivitis and stomatitis are caused by negligence of the mouth, and by the processes of fermentation within it. In exanthematic diseases, the exanthem, which appears the same on the mucous membrane of the mouth as on the external skin, causes stomatitis. Other specific stomatites are the result of certain fungi and poisons (aphthæ, syphilitic or mercurial stomatitis, etc.).

During difficult dentition the gums are swollen, the redness is increased, they are hot to the touch, and painful on pressure.

The appearances are somewhat different when the inflammation is caused by uncleanliness of the teeth. The diffusely hyperæmic gum does not swell materially, but becomes eroded at its free margin at the neck of the tooth. The epithelium becomes loosened and the intradental papillæ lie free (gingivitis simplex); the slightest contact is painful and causes bleeding, so that the patient hardly dares to eat; under all circumstances they avoid masticating solid food. Consequently the dirty deposit on the teeth increases still more, and is finally mingled with the exudate from the inflamed gums. The exudate thus becomes of a fœtid nature, and leads to ulcerous destruction of the gum (gingivitis ulcerosa). If this condition is still further neglected, it may result in partial necrosis of the alveolar process, as the periosteum is destroyed.

From this inflammation must be differentiated scorbutic inflammation, which accompanies scorbutus. In this the gums are dark-blue, relaxed, swollen and bleed readily. Ecchymosis may be seen in several places. The gums not only bleed at the free margin (as in gingivitis simplex) but on their entire surface. The diagnosis of scorbutus in such cases can be established almost certainly if the patient complains of a tired feeling in the limbs, and the lower extremities are swollen, and especially when there are hæmorrhages of the skin in the calves of the legs.

In mercurial stomatitis, certain fungi grow on the mucous membrane, which results in necrosis of the deeper layers of

epithelium, and this combined with the fungous growth forms a grayish-white membrane, which leaves the ulcerous surface bare after its exfoliation. The fungous collection is possible because the upper layers of the epithelium of the mucous membrane of the cheek, of some parts of the gums (as for instance between the ages of seventeen and twenty-four over the third molars), and of the tongue, which is swollen from the effect of the mercury, are readily abraded during mastication. But under the influence of these mercurial preparations, which are excreted by the saliva, the loss of epithelium is not replaced with a sufficient rapidity, because mercury preparations have a retarding influence (keratolytic) on the formation of epithelium.* Upon the eroded epithelial surface the fungi readily find lodgment, and their presence causes necrosis of the deeper layers of epithelium. Formerly extensive destruction of the oral mucous membrane, followed by deformity, occurred frequently as a consequence of mercurial stomatitis. At present, by the observance of caution, the bad results can be prevented.

The treatment of difficult dentition was given in Chapter II. Specific inflammations require specific treatment. We deal at this point only with the inflammation that results from neglect in caring for the mouth. As the ill results are caused by the corroding mucus on the teeth, our first effort should be directed to its removal. This result is attained by washing and cleansing with cotton dipped in carbolized water or a solution of corrosive sublimate. The tartar that may be present, or at least the principal portion of it, should be removed also. The patient must then be given to understand that a cure can be attained only if the irritating mucus is prevented from appearing, and that for this purpose the teeth must be cleaned with a soft brush three times a day. For the purpose of rinsing the mouth a 3 to 100 solution of chlorate of potash may be recommended. The mouth should be rinsed frequently, as often as every half hour. With this treatment the border of the gum is generally nicely granulated as early as the third day, and becomes hardened and does not bleed. Only a slight redness may be now noticed. And in order to remove this entirely the treatment is continued for eight days, and the observance of thorough care of the mouth is insisted upon.

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* See Bockhart, *Zur Ætiol. u. Beh. d. ulcerösen Mercurial-stomatitis* (*Monatshefte für prakt. Dermatologie*, Vol. IV., No. 8, Aug. 1885).

Inflammation of the mucous membrane of the tongue and the cheeks, as well as of the pharynx, sometimes occurs in connection with inflammation of the gums. The treatment usually employed consists in rinsing the mouth with chloride of potash solution, alternating it with lime water. Ulcerations of the buccal or lingual mucous membrane are sometimes caused by sharp edges on the teeth. In these cases the teeth causing this should be extracted, or filled, or at least the sharp angles should be rounded off, when the ulceration will heal. Mucous plaques are not likely to be confounded with such ulceration. Should there be a doubt, the favorable or unfavorable result following the remedy applied to sharp angles will point out the presence or absence of a specific disease.

Inflammation of the floor of the mouth sometimes occurs from salivary deposits within Wharton's duct. [This condition is usually termed Ranula.] In consequence of the irritation that the foreign body exerts in the vicinity, an inflammatory infiltration results, which is resorbed in some cases, and then again reappears. In a case under my observation the swelling frequently appeared and disappeared spontaneously during three years. Generally the inflammation finally results in the formation of abscess. During stages of infiltration the deposit can be felt, but sometimes its presence can be only surmised, as inflammations of the floor of the mouth occur but seldom. It is singular that patients affected in this way always complain of pain in teeth of the lower jaw, and occasionally in those of the upper jaw. One may be led to the opinion that the inflammation is alveolar periostitis, which occurs but exceptionally on the lingual side. This, however, may be excluded with certainty if there are no carious teeth in the arch, and if the pain on the lingual side is less on pressure than in the floor of the mouth. After lancing the abscess the salivary calculus may be readily found with the probe, and removed. Occasionally, in addition to a large one, there may be several smaller deposits within the ducts leading from the gland.

[Cellulitis of the Floor of the Mouth.

A peculiar inflammation of the floor of the mouth occurs occasionally, which may be called a cellulitis. Ten cases that I have

met with agree in the general conditions and appearance. The inflammatory movement seems to affect especially the loose cellular structures of this locality, and cause great swelling of the parts. In most of these cases the swelling was so great and so located that the ridge upon which the ducts of Wharton open under the tongue was protruded over the edges of the lower incisors, giving a markedly characteristic appearance. In several the inflammation has been confined to the region under the anterior portion of the tongue, but in some it has been much more extended, involving the tissues of the angle of the throat and neck. The skin has not been involved in any of these, nor has there been seen a disposition to the formation of pus in the tissues affected, except in two cases, which arose in connection with acute alveolar abscess. In these the pus cavities did not extend far from the lingual border of the lower maxilla.

The immediate cause of this affection has been traced uniformly to some injury, or to the extension of inflammation from diseased teeth. In one case to which I was called, a tooth, a lower bicuspid, had been extracted two days before. The ridge formed by the mouths of the ducts of Wharton protruded over the lower incisors, giving the characteristic appearance of a double tongue. The loose tissues about the floor of the mouth, angles of the neck and pharynx were œdematous and greatly swollen, so much so, indeed, that suffocation seemed imminent. A bistoury was passed into the tissues in several directions, to give exit to the serum with which they were distended, and brisk catharsis promptly established with the effect of mitigating the urgent symptoms, and the difficulty passed away in the course of a week.

Another case arose from a slight prick of an instrument occasioned by a slip during the excavation of a carious cavity. Others occurred from like trifling causes.

The real cause of this difficulty is most likely a peculiar septic infection, which becomes implanted in the tissue injured. It presents some similarity to the erysipelatous affections.

In its treatment I have found the greatest benefit from brisk saline cathartics. In case the swelling is excessive, incision for the discharge of the serum may be resorted to. The affection seems to run its course in about ten days, when the symptoms gradually disappear.]

Hypertrophy of the Gum.

Two forms of this disease are recognized. The usual form consists in a growth of the free border of the gum, which lies loosely against the teeth, sometimes reaching down as far as the cutting edges. Generally the lower incisor teeth are covered to the greatest extent by the gums. This form is especially present in women during pregnancy. Treatment consists in cutting away the borders with scissors. After pregnancy the hypertrophy of the gums usually again re-appears. Occasionally it remains for years, and invariably returns after removal. In these cases removal should always be resorted to, but reproduction may be expected at the climacteric period. In the most obstinate cases extraction of the teeth, which are generally loose, will effect a cure; for it seems that no hypertrophy of the gum can exist on the toothless alveolar process.

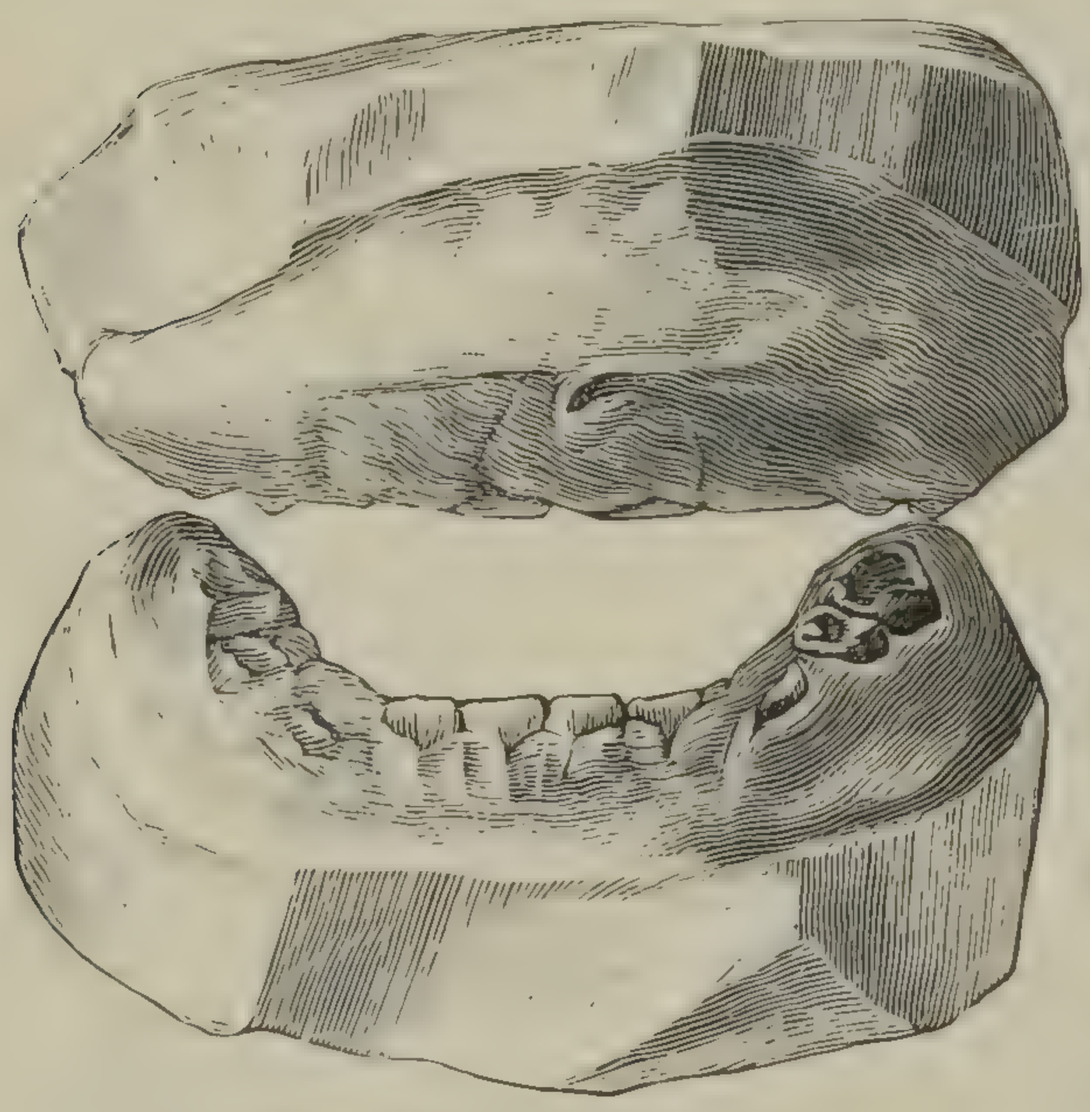


Fig. 26.—*Hypertrophy of the Gums.*

Another form of hypertrophy of the gums consists in thickening of the entire gums. The external surface is granular and warty, the hypertrophied gum seems firmly attached to the bone, and covers the teeth to such an extent that only the masticating surfaces are visible. The hypertrophied portion is firm and dense. The upper lip cannot cover the massive new growth, and the patient is thus led to seek relief on account of the deformity. Such cases are rare. Heath has treated two such cases by the removal of the alveolar process.* I saw such a case of hypertrophy (See Fig. 26) in the case of a girl four years of age, who suffered at the same time from general hypertrichosis. Hypertrichosis is sometimes accompanied by a faulty dental development. This seems to be the case, however, only when the hair is silky and soft (lanugo), and

*Transactions Odont. Soc. Gr. Brit., 1878, Dec.

contains only a small amount of pigment. If, however, the hair is strong, thick and black, the dentures are normal (as for instance in Krao, who, aside from this, has also circumscribed hypertrophy on the gums), or, in addition to the normal dentures, a diffuse hypertrophy of the gums is found in these persons. Thus the well-known Julia Pastrana, according to her photographs, had the same hypertrophy of the gums I observed in a four-year-old child.

Of the tumors of the gums, epulis and carcinoma have been already mentioned. I wish here to mention only tumors of the vessels. Aneurisms of the palatine artery have been frequently observed; under certain conditions they may be mistaken for alveolar abscess. I had the opportunity of treating an aneurism of the mylo-hyoid artery at the Surgical Polyclinic. A lady, thirty-five years of age, complained of the bleeding from the gums, which was repeated several times during the day and three or four times during the night. The patient was very anæmic, and did not dare to eat, as contact with the food always brought on the bleeding. On the gum there was nothing abnormal to be seen, aside from a slight swelling from 3 to 4 mm. in diameter, but of the normal color of the gum, and located behind the anterior left central incisor. Immediately behind this tooth there was a collection of black coagulated blood on the swelling. The latter was soft on pressure, as a small empty abscess would be. Pulsation was unobservable, possibly on account of the diameter of the artery and of the coagulum. Treatment consisted in cauterizing with Paquelin's thermocautery. After the first introduction of the cautery a copious spurting bleeding took place. After that I passed it about the lower border of the swelling, and confined myself to checking the blood with the cautery. The bleeding finally ceased and the aneurism healed.

CHAPTER IX.

NEUROSES FROM DENTAL LESIONS.

When dealing with the subject of pulpitis, special attention was called to the fact that the pain is frequently difficult to localize. The patient often points out a tooth in the opposite jaw as the painful one, as for instance an upper molar instead of a lower one, and *vice versa*. At other times a bicuspid is pointed out instead of a molar, sometimes a molar instead of a cuspid, and again a cuspid instead of a third molar of the same jaw, etc.

The physician frequently has much difficulty in convincing the patient that the pain arises from some other tooth, and not from the one in which the patient imagines it to be. In these cases the radiation of the pain is the cause of the erroneous indications.

As in these instances the pain from the upper jaw radiates into the lower or from a third molar to a cuspid, in other cases it may extend still further, and the pain may be felt in the face, on the side of the head, in the ear, back of the head, and infrequently it radiates into the back and to the upper extremities. Sometimes it may be observed that in consequence of tooth-ache a hyperæmia of the temporal region and of the whole face may arise; the conjunctiva appears red, and tears flow from the eyes. A slight touch of the lips may occasion severe twitching of some of the muscles of the face, etc.

While in these cases the reflex action of nervous irritation may be observed almost directly, there are a number of other cases in which tooth-ache is not the prominent symptom, though a dental affection is the cause of neuralgia of the infra-orbital, supra-orbital, mental, malar, auriculo-temporal, or occipital nerve or tympanic plexus. This connection can be only surmised, and is based on the frequent experience that after the treatment of a diseased tooth such pains are allayed. Very distinct neuralgia of the nerve-branches just mentioned is frequently caused by a chronic irritation or acute inflammation of a tooth-pulp, or by irritation and inflammation of the root-membrane. Neuralgia has been frequently treated with-

out success for months and even years, but was cured after the extraction of a diseased tooth. In my own experience I recollect several cases, and among them a few serious ones, which were treated in vain as neuralgia for weeks and months, and were cured after the extraction of a tooth. In our literature numerous similar examples are on record.

Aurists have made it almost a positive rule to examine the dentures if a patient complains of tearing pains in the ears, and if an objective examination of the organs of hearing does not give any satisfactory indication as to the origin of this lesion, and nearly all cases in which the cause is looked for in affections of the teeth, the diagnosis is confirmed. Not only is neuralgia of the tympanic plexus often kept up by affections of the teeth, but occasionally diseased teeth may be the cause of inflammation in the organs of hearing.

Eye troubles due to dental lesions are not so frequent as ear troubles due to this cause; but there are numerous instances on record. Affections of the optic nerve and of the retina have been in certain instances traced directly to diseases of the teeth, as well as disturbances of the motor apparatus, diseases of the lachrymal ducts, etc.

In a number of cases epilepsy has been considered as resulting from diseases of the teeth, and recently by Schwartzkopff* and Liebert.† In a few cases, the patient experienced, prior to each attack, an abnormal feeling in the tongue, and was unable to use it in a normal manner.

All this is evidence of the fact that in many cases of neuralgia, especially if within the field of the trigeminus, the physician should examine whether there is not some lesion of the teeth that causes the suffering.

Of the affections of the teeth that are most frequently the cause of neuralgia, pulpitis is the most prominent one. Generally the patient energetically disputes any connection between the two troubles, but the error is shown after the treatment of the diseased tooth. It is necessary to be cautious, and not to be misled.

Of other diseases of the teeth that may cause neuralgia, may be mentioned hyperæsthesia of the dentine, inflammation of the root-membrane, exostosis, pulp-stones within the pulp-chamber,

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**Deutsche Monatsschr. f. Zahnh.*, 1884.

†*Deutsche Medic. Wochenschr.*, 1885, No. 37.

difficult dentition, alveolar periostitis, and gingivitis. All of them together are not by far so frequently the cause of nervous derangement as inflammation of the pulp alone. This should be remembered in making the diagnosis.

Sometimes the relation between neuralgia and toothache is reversed. When, for example, there is a decided infra-orbital neuralgia, the bicuspids and the cuspid are painful as a rule. It must be ascertained then whether these teeth are healthy, and painful only in consequence of the neuralgia, and then whether the neuralgia is not due to some other diseased teeth. If no diseased tooth is to be found, an idiopathic neuralgia may be presumed to exist. It is well known that at its exit from the canal bearing its name the infra-orbital nerve is painful to pressure, if affected by neuralgia. This symptom is present in any case, whether the neuralgia be idiopathic or the result of diseased teeth. This sensitiveness to pressure may be present also during dental and alveolar periostitis, before the swelling becomes noticeable. Hence, not only the presence of pulpitis, but of periostitis of the teeth also, should be excluded before the presence of neuralgia can be entertained.

In making the differential diagnosis between idiopathic neuralgia of the trigeminal nerve, and a neuralgia arising from diseased teeth, it is essential above all things to become satisfied whether the pain arose suddenly or gradually. The former would indicate idiopathic neuralgia, while the gradual increase of pain indicates disease of the teeth. Thus, for instance, during neuralgic pains from exostosis of the roots and dentine-formations in the pulp-chamber, the pain increases gradually. Periostitis is felt in the teeth before it has resulted in neuralgia. The former may, however, become less intense, while the latter increases in intensity, and thus the origin may be obscured. If pulpitis is the cause, the patient has been unable to bear cold water in the mouth, for some weeks before neuralgia appeared. This fact may have been forgotten, for sometimes neuralgia does not appear for six months or more after the first indications of pulpitis were present; and first when but a few fibres of the pulp are present, the remainder having decomposed. In these cases the carious cavity and the remnant of the dead pulp would be certainly discovered.

Teeth that externally have the appearance of health may be the cause of neuralgia. Dentine-formations in the pulp-chamber may

cause continual irritation. These cases are exceedingly difficult of diagnosis. These teeth sometimes appear to be deadened or "furry," and they react painfully to cold water. But these indications may appear in teeth that are painful from idiopathic neuralgia. Generally, if there are no carious teeth in these cases, the presence of idiopathic neuralgia may be considered the cause; but if it does not yield to treatment, and if the patient positively declares that the attacks of pain originate and terminate in a healthy tooth, dentine-formations of the pulp of that tooth, or an exostosis of its root, may be the cause.

The treatment of neuralgia arising from affections of the teeth consists in treating of the diseased teeth themselves, as explained in preceding chapters. If the presence of a dental affection cannot be certainly ascertained as the cause of the neurosis, at least in the part supplied by the trigeminus, it is nevertheless advisable that all remnants of teeth that may possibly cause a chronic inflammation should be removed, and the dentures generally placed in such a condition that the teeth may be excluded as the cause of the neurosis.

Numerous cases of neurosis arising from dental affections may be found cited in Baume's "Lehrbuch der Zahnheilkunde," in Arkövy's "Diagnostik der Zahnkrankheiten," in Wedl's "Pathologie der Zähne," in twenty-five volumes of the "Viertelj. und Monatss. f. Zahnh.," etc. [Also in all works on dental surgery, and the periodical literature of the United States, Great Britain, etc.]

CHAPTER X.

THE FILLING OF CAVITIES IN THE TEETH.

The indications for filling have been casually referred to in previous chapters. It may be again re-iterated at this point, that in simple caries, before the pulp has been reached by the carious process, filling is of far more advantage than at a later period.

The filling of teeth in these cases is one of the most successful operations that is performed on the human body. It consists principally in the fact that the softened mass is removed from the carious cavity, and replaced by a firm indestructible mass, which is fastened therein. Extensive experience and a large number of instruments are necessary in order to operate successfully in all cases.

The operation is divided into two parts: *first*, the preparation of the cavity; *second*, the filling of the cavity. One step is as important as the other. The slightest defect in either makes the result entirely questionable. Thoroughness and specially care are most important essentials expected of an operator who undertakes filling of teeth.

The Preparation of the Cavity.

Prior to filling, the cavity must not only be entirely cleansed from all carious masses, but it must also be shaped in such a manner that the material with which it is to be filled is firmly retained, and that the borders of the cavity are not fractured in mastication.

The operation is begun with the preparation of the entrance to the cavity. But in order even to reach this it is often necessary to previously obtain access. This is especially true of the upper incisors, which frequently decay on the approximal surfaces, and are so close together that a tooth may entirely cover the cavity in an adjoining one. Hence the teeth must be separated. This can be done with the least pain with cotton, of which a small quantity is rolled together and drawn between the teeth. In most cases it is possible in this manner to drive the teeth sufficiently apart, that

the cavity may be filled. Sometimes the teeth yield so little that it is necessary first to separate them with a thin spring file before the cotton can be introduced. Instead of cotton, wood may be used. More powerfully distending substances such as laminaria and rubber are also used, but they exert such great pressure upon the periosteum of the tooth that inflammation may result. These substances can therefore be employed for a few hours only, while cotton, as a rule, may be permitted to remain until the next day. When the teeth are separated the borders of the cavity are removed. As decay within the dentine progresses more rapidly than in the enamel, the latter is generally undermined. The walls of the cavity must be supported by the dentine, because enamel is very brittle, and hence breaks readily during mastication.

For cutting away the borders of the enamel chisel-shaped instruments are used (See Fig. 16). A moderate pressure is exerted with the instrument in the direction of the enamel prisms, or toward the pulp. This leaves sharp edges, which must be rounded and polished. This is done with small corundum and Arkansas stones of various shapes, which are used in the dental engine.



FIG. 27.—*Excavators.*

When the borders of the cavity are strong and rounded off the next step consists in excavating the carious mass. For this purpose there are small, variously shaped chisels and spoons known as excavators (See Figs. 15, 17 and 27). With these the softened dentine is removed nearest the border of the cavity at first, and gradually the lateral walls are thus cleansed, and finally proceeding into the base of the cavity, the last layers are removed from its floor. The patient occasionally experiences pain, which is sometimes, especially near the union of dentine and enamel, very marked; at these points excavation is frequently more painful than in the

immediate vicinity of the pulp. Contact with the pulp is also painful.

In order to alleviate pain in the dentine during excavation, a number of cauterants and local obtundants are employed, which are allowed to remain according to circumstances for minutes, hours and even a day, to exert their influence. (Cold should not be resorted to, as it is generally painful.) Most frequently carbolic acid, chloride of zinc, iodoform, and more recently cocaine have been employed, but the latter without entirely satisfactory results. Herbst recommended ether and sulphuric acid, five to one, and Arkövy recommended aconite. Arsenic, which destroys the pulp, should not be used unless the latter is exposed, because it may create a congestion within it, which may finally result in gangrene.

The most favorable cases for filling are those in which the pulp has not been approached. (If the pulp is already inflamed or gangrenous, having been perforated by caries, treatment is resorted to as previously described. After the filling of root-canals the procedure is the same as about to be described.) The filling can be finished at one sitting without any fear that any pain will follow it. The walls of the cavity should be generally so strong that there is no danger of their fracture in the future, and the cavity should not be so large that the prospects of its retaining the filling for a long time are unfavorable; sufficient anchorage, however, must be secured. In order to attain this result, after the carious mass is removed from the cavity, this must receive a certain proper form. The simplest are those cavities on the masticating surfaces of molars to which a cylindrical form is readily imparted. In these cavities any filling material is readily retained, but it is essential when filling with adhesive gold to first cut small grooves for retaining the first pieces in position. Small cavities on approximal surfaces are prepared in the same manner. The chances of retaining the filling are increased, especially if the cavity is not deep but flat, and if the opening is left somewhat smaller than the cavity itself, so that a properly shaped cavity is a cone whose base is the floor of the cavity.

To shape a cavity properly, when the defect extends over one or more surfaces of the tooth, is more difficult; sometimes the masticating surface of the molar is also attacked when the approximal surface is entirely destroyed. We then have a cavity

whose internal diameter can be no larger at any point than the diameter of its opening. In these cases the filling must be retained in a peculiar manner. This is done by cutting a groove along the cervical margin (that portion of the cavity at the neck of the tooth and under the gum), and also opposite in the walls of the masticating surface. If the lateral walls are not too weak, small pits may be drilled in them. For the purpose of cutting these pits there are generally employed at present small wheel-shaped or inverted cone-shaped burs (Fig. 28), which are used in the dental engine. In making these pits care should be taken not to overdo the work, and thus to weaken the wall, which may be fractured in the future, and also not to injure the pulp when it is not yet exposed. The chips are blown from the cavity with a chip-blower or washed out with medium warm water.

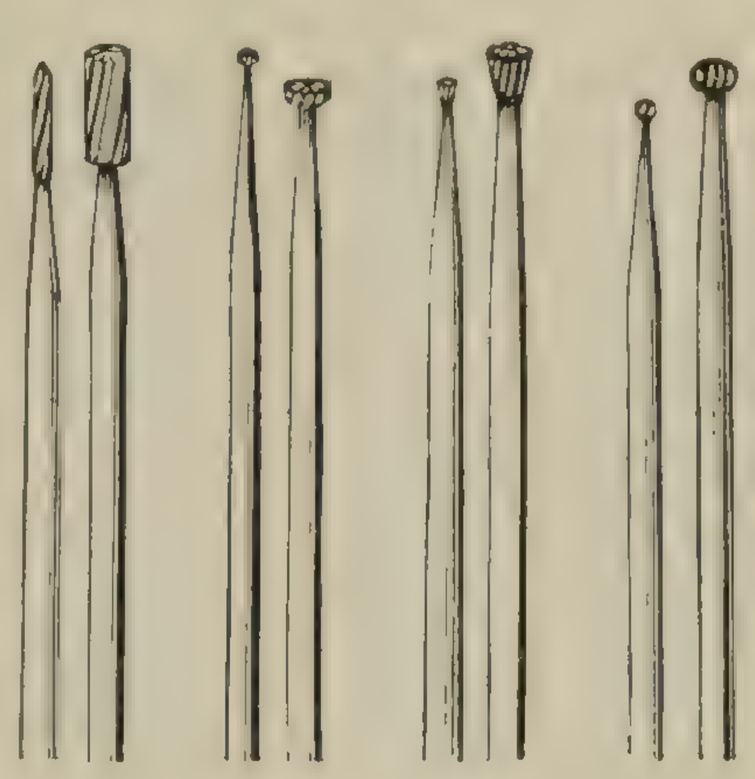


FIG. 28.—*Burs.*

EXCLUSION OF MOISTURE FROM THE CAVITY.

When the cavity is prepared, the instruments for filling are placed in position, and means sought to control the saliva. This may, however, be done previous to the preparation of the cavity, and it is also advantageous in preparing the cavity to keep it dry. The best means for this purpose is the thin rubber-dam, which is somewhat thicker than gutta-percha paper. If it is to be applied at all, it is generally best to do so previous to excavating the cavity. The sheet selected should be at least of sufficient size, that when the mouth is open it may be entirely covered with rubber; from it there should only project the tooth to be operated upon and its two adjoining neighbors; two additional teeth may also be included. The necks of the teeth which project through the rubber should be closely encircled by it, so that no saliva may pass through it. As many openings should be made in the rubber, as there are teeth to project through it. This is done with a rubber-dam punch, similar to a conductor's punch. The holes should be about the width of a tooth from one another. When the dam is slipped over the teeth, it is tightened by a rubber-dam holder, which is provided with

clamps fastened on each side of the rubber and passed around the head of the patient, thus exerting tension from right to left. For the purpose of tightening the rubber downward, weights are attached to it. The teeth are often of such shape that the rubber readily slips from them. In order to prevent this, it should be ligated; for this purpose waxed silk or cotton thread is used, which is tied around each tooth, and pressed upward or downward, as the case may be, under the border of the gum. Where ligatures of such thickness cannot be used, clamps are employed, which are placed in position with forceps specially made for this purpose. There are hundreds of shapes and sizes of these clamps in the market, of which number from eight to twelve are necessary to supply such cases as most generally occur in practice. In some patients the flow of saliva during the operation is so copious, that it may flow under the rubber-dam over the lower lip upon the clothes of the patient. In order to prevent this, a rubber-dam bib is fastened around the neck of the patient and in this way the saliva is collected. There are also variously constructed saliva ejectors or pumps for this purpose.

Upon the short molar teeth of children and upon the conical partly erupted third molars of some patients the rubber-dam cannot be fastened. In these cases, as well as in those in which the patient cannot bear the rubber, and if the operation of filling will take but a few minutes, while the application of the rubber-dam may be very difficult and tedious, punk, small napkins, bibulous paper or lint wrapped in mull may be packed about the teeth. In these cases one hand of the operator must be free in order to retain these absorbent materials in position: all preparations should therefore be complete, so that the work may be done with one hand. In some cases the patient may depress the tongue and hold the napkins, etc., in position with a spoon-shaped instrument provided with a long shank and handle. In addition to this, there are tongue-depressors made for this purpose, which at the same time serve to assist in retaining the mouth open. There are patients, in whom on account of uncontrollable irritation, and hence a tendency to vomit, none of these means can be employed. In such cases the operation of filling must be short and simple; gold filling cannot be introduced into the lower molars, because gold will not weld if there is the slightest moisture either in the cavity or upon the surfaces of the layers of gold. The breath of the mouth and nose is injurious, and should

be prevented from collecting upon the gold while filling. The most certain way to retain the tooth dry for a long period is by the use of the rubber-dam; hence it is always used when the absolute exclusion of saliva is necessary, as in gold-filling and in the antiseptic treatment of the pulp.

Materials for Filling Teeth.

Materials employed for filling teeth should be those that are as much as possible similar in their physical properties to dentine (expansion under warmth, property of conducting heat, etc.), they should be readily applied to the walls of the cavity, and in such a manner that no space remains between them. In addition, the material should not be changeable chemically or physically in the fluids of the mouth. Such an ideal filling material is as yet unknown. It is the problem of chemistry to furnish one. The cements that are at present useful, and that consist principally of oxyphosphate of zinc, fulfill many of the requirements of a good filling material, but not the most important one, that of durability. If we could expect from a cement filling ten years of service, instead of three, gold, which requires care in working, and is expensive, would not be necessary. Meanwhile in most cases gold is the best material for filling.

As a general rule, *gold* is used in the form of very thin beaten leaves (gold-foil), from which ribbons are cut, and these are either introduced directly or first rolled into cylinders. There are also small, variously shaped pieces of gold (pellets, which are composed of a number of layers of thin gold-foil). Small pellets or balls may also be rolled from gold-foil, and these can be pressed into the cavity, etc.

Gold-foil may be cohesive or non-cohesive. The uses of these two different kinds in filling are different. There is also used a gold that is crystallized from a solution of gold, and which is known as sponge gold or crystal gold. This, as well as all gold that is to be employed as cohesive gold, must be annealed before using. Non-cohesive gold does not cohere, because its surfaces are not perfectly clean and dry. Gases and moisture from the atmosphere, which become deposited on the gold, destroy the cohesive property of one leaf to the other. In freshly annealed gold cohesion is very powerful, so much so that two leaves laid together unite, and in the

attempt to separate them they are torn. Cohesive gold, however, is somewhat harder and not so malleable or so soft as non-cohesive gold. Recently, however, a gold-beater (Wolrab) in Bremen has produced a preparation of gold which is soft and cohesive at the same time. Gold is to be recommended in all cases of filling in which the price is no objection, and if the tooth does not threaten to break under the force necessary to introduce it. It should not be placed upon the exposed pulp or into the vicinity of the pulp, as it will produce irritation, for it is a good conductor of heat. It is a good plan to place a non-conducting substance, a cement, between it and the pulp. Gold is especially desirable for anterior teeth, for which the use of amalgam is excluded; as gold is used in a chemically pure state, it undergoes no change in the mouth, but remains for a long time, and protects with certainty from any further progress of decay, provided it is properly introduced.

Tin finds limited application. It is used the same as gold-foil and is handled in the same manner as non-cohesive gold, is somewhat softer than gold, but does not look as well, and is adapted more closely to the walls of the cavity than amalgam.

Amalgams consist of alloys of gold, silver, tin and mercury. Occasionally a small quantity of platinum or copper is also added. The best preparations are those that contain about five per cent. gold, fifty per cent. silver, and the principal of the remainder tin, with small additions of platinum. Of such preparations there are many on the markets, and at present in Germany that of Oehlecker seems to be much favored. [In the American market there is a very large assortment of these alloys.] The metals used for the preparation of these alloys should be chemically pure. Small quantities of arsenic, etc., would make the alloy useless. The gold, platinum, silver, and tin are melted together, and the alloy made into filings with a file. Of these filings a small quantity is taken for use and is rubbed together with mercury. The mercury should also be chemically pure; at present it is purified by electrolysis. The alloys may be mixed with various quantities of mercury. The majority of practitioners claim that amalgam is better in proportion as it contains less mercury. Some experiments, however, seem to prove that amalgams containing a medium quantity of mercury are better; for some preparations a large amount of mercury seems to be used. Amalgam that is mixed too dry, or has not sufficient

mercury, has the disadvantage of being difficult of manipulation. That containing too much mercury is, on the other hand, too soft, and hence readily displaced after filling. The best method for the majority of preparations is undoubtedly the use of a medium quantity of mercury. In this way a paste is made, which, upon being pressed in a cloth, or a piece of chamois skin whereby the excess of mercury is squeezed from it, breaks with difficulty, but in no instance crumbles as dry amalgam would. After the operation of filling is completed, such an amalgam generally has sufficient hardness to permit of its being almost sufficiently polished.

[However, every amalgam filling should be carefully polished after it has perfectly hardened, *i. e.*,.after one or two days have elapsed. The too common practice of finishing amalgam fillings at the same sitting at which they are inserted, cannot be too strongly condemned, for in the attempt to do this and give the filling a reasonably good outward appearance, some portion of the adaptation to the margin of the cavity is pretty certain to be moved, rendering it imperfect at this point, thus destroying the usefulness of the filling. On the other hand, if the polishing is delayed one or two days, the margins can be perfectly finished. This perfection of the margins is the most important point to be attained in a filling, for upon this depends its usefulness.]

Copper amalgams are made by mixing mercury with precipitated copper. It is placed on the market in the shape of rhomboid pieces, which are warmed over a spirit lamp before using. This causes the appearance of particles of mercury on the surface of the gray metal; hereupon the warmed pieces are triturated in a mortar until they are of the desired plastic consistence. This amalgam does not seem to be poisonous, notwithstanding its coppery contents, and conserves the teeth for a long time. It is, however, not to be used in any other than the most posterior molars because it turns the tooth black. Neither should amalgams containing gold be employed in the anterior teeth because their discoloration produces disfigurement. The discoloration is due to the silver it contains and to the formation of sulphide of silver. These amalgams may be used, however, in the bicuspids and molars if gold, on account of its expense, cannot be employed. The incisors and cuspids must be filled with gold under all circumstances, but if too expensive, the less durable cement must be resorted to.

All amalgam fillings change in the mouth. Generally it will be found after a number of years that a space exists between the filling and the walls of the tooth, so that a fine excavator can be made to enter. From these spaces caries may again begin, so that finally the filling will not suffice. Small amalgam fillings, however, protect for many years, perhaps for twenty; for the large fillings a duration of six to twelve years is not uncommon.

Cements.—Of several dozen of these preparations in the market, which differ from one another more or less, there are principally two classes: oxychloride of zinc and the oxyphosphate of zinc. The phosphate of zinc is generally a crystallized mass which becomes liquid on the application of heat. The warm fluid is mixed with oxide of zinc to the consistency of putty, and this is colored by the various additions of coloring matter to correspond to the different colors of the teeth. Oxychloride of zinc consists of a concentrated solution of chloride of zinc, mixed with a considerable quantity of oxide of zinc until a stiff paste is produced. The oxychloride of zinc is the older preparation, and protects the tooth as long as even one-half of the filling remains. But finally, by the gradual wearing out of the mass, defects occur, wherein particles of food become lodged and decay. The filling must be renewed in these cases. Renewal of the fillings is generally necessary in two years. In some mouths, however, oxychloride of zinc fillings last as much as ten years.

Oxyphosphate of zinc is very changeable in its properties. If the preparation is a good one, on an average five or six years duration of the filling may be relied upon. Nevertheless, even the best preparations are destroyed in some mouths in two or three years. Poorer preparations last but one or two years, and in positions where the mass comes in contact with the gums it sometimes disappears in six months. Even the most experienced practitioner will find it impossible to be able to judge whether a preparation is good or bad by simply using it. Under all circumstances the cements are the less reliable materials for fillings, and one who has such fillings in the mouth, especially if they are in cavities which extend underneath the margin of the gum, should have them examined every three or six months, as otherwise there is danger that by the destruction of the cement at the cervical margin of the tooth, acute caries may progress until the tooth is fractured.

[Much the better plan is not to depend upon the cement fillings

at all, except for the most temporary uses. They answer an admirable purpose when it is necessary to employ a non-conducting filling for a time as a protection against thermal changes, or when for any cause it is advisable that the permanent filling be delayed for a time. They are also invaluable for capping exposed pulps and as non-conductors of heat placed between gold fillings and the deeper parts of cavities. The patient may also be saved much of the inconvenience of long operations in packing gold, by filling the deeper parts of the large cavities with cement.]

In those cases in which the cavity extends below the cervical margin it is advisable to fill the tooth with amalgam around that margin as far as the gum reaches, and to fill the remainder with cement.

Gutta-percha is a temporary filling material. For use as a tooth-filling it is mixed with silicic acid in order to harden it. Nevertheless it is worn off on the masticating surfaces within a few months; on the proximal surfaces it will last a long time, as much as from two to four years, but its longest period of service is ten years or more, on the proximal surfaces of the molars. Over other filling materials gutta-percha has the preference by being a poor conductor of heat. It is therefore well adapted as a foundation for amalgam if the cavity extends near the pulp.

Introduction of the Filling.

Soft gold is generally introduced in the form of cylinders into the cavity, which should be, if possible, cylindrical in shape. Cylinders of gold should be somewhat longer than the cavity, in order that they may project from it. In this manner one after another is introduced and condensed, shaped in such a manner that the gold is driven to the walls of the cavity. When the cavity is tolerably well filled, cavities are made between the layers of gold previously introduced, with cone-shaped instruments, and into these more gold is wedged. Finally, the surface is condensed and polished. As soft gold adapts itself very readily to the walls, some use it for lining the cavity while the remainder of the filling is made with cohesive gold.

Cohesive gold is used in the shape of cylinders, ribbons, pellets, etc. The first piece is lodged and fastened in the retaining pit or groove. Several other pits or grooves are also filled. Then gold is

carried from point to point until the pits and grooves are all united. This is continued until the cavity is filled, during which operation the greatest care should be exercised to secure perfect adaptation of the gold to the borders. Hence only small particles can be condensed at a time. The layers are frequently condensed with the mallet. For this purpose there are various kinds of hand mallets, engine mallets, electric and pneumatic mallets. Special care should be taken that the finishing layers should be well adapted and properly condensed, that a perfect smooth surface may be attained, and that at the same time the adaptation to the walls of the cavity should be as perfect as possible. The cavity should be filled fuller than necessary, in order to allow excess for polishing, and that no depressions remain in the filling. After the last layers have been condensed with the mallet, the gold should be polished toward the borders with a burnisher. The excess should be removed with a file, alternating the filing repeatedly with the burnishing. Emery paper should be used to secure a smooth surface. There are at present disks made of emery or sand-paper, which are used with the engine. By the use of Arkansas or blood-stone (which are driven in the same manner) the surface can be made firmer and smoother. Finally the polished gold is deadened with a stick of wood dipped in powdered pumice.

As cohesive gold becomes firmly attached, one piece to another, it is possible to build up corners, contours, edges, and even crowns. In the anterior teeth such fillings are unsightly and it is best to use artificial crowns made of porcelain.

Instead of the hand mallet, some use small variously shaped instruments, which are put in motion by the engine. These are used by repeated thrusts while rapidly rotating, upon the separate layers of gold (Herbst's rotation method). Any one familiar with this rotation method can secure a closer adaptation of the gold to the walls than with the mallet. Non-cohesive gold may be employed, and nevertheless cohesion secured with the gold already condensed by the rotating instrument. It is essential, however, that the cavity should be entirely encircled by a wall, and where either is missing, as for instance in a molar, where the entire distal surface and part of the masticating surface has been destroyed, an artificial wall is made with a steel matrix fastened between the teeth. If a corner, or a quarter, or half of a crown is to be built up, the shape of the

crown must be negatively restored with steel bands held together with shellac. Only one side is permitted to remain open and from that side the gold is introduced. The reproduction of the missing walls by steel bands or matrices is also advantageous when malleting is employed.

Crystal gold is used in the same manner as cohesive gold. Some preparations are very loose and spongy, and require much time to condense. The more solid crystal gold, however, must be used in smaller portions; when larger pieces are employed some parts may remain uncondensed.

Tin is employed in the same manner as non-cohesive gold. Its use is not very frequent. Those practitioners that use it frequently, claim that it is better adapted to children's teeth than gold. Some use a combination of tin and gold, by rolling together into a cylinder one sheet of gold and one of tin, or *vice versa*. As tin is softer than gold, it is claimed that with this combination a closer adaptation of the metal to the walls of the cavity is secured.

The amalgam is divided into small particles, corresponding with the size of the cavity; of these one piece after another is introduced and pressed into position. The surface is smoothed with a burnisher. The patient is requested to close the mouth so that any excess may be pressed away by the articulation of the opposing tooth. The filling is then again polished and the material pressed, especially against the margins, for in closing the entire filling is displaced, if even but slightly too large. The closing of the mouth and the polishing are alternately continued, until no more of the amalgam is displaced. These precautions are especially important if the filling is very large on the molars and if it extends over two surfaces. Finally it is advisable to polish the filling again after it is completely hardened, say in about two hours, though generally it is best to have the patient call the next day for this purpose.

[In biting down upon an amalgam filling as recommended above, especially if the cavity have more than one wall lacking, *i. e.*, if the filling extends to any other than the grinding surface, its perfect junction with the walls, especially the margins of the cavity, is liable to be seriously disturbed, and thus the usefulness of the filling destroyed. I therefore regard it as better to finish the filling without this procedure. Then the teeth may be brought very gently together at first, and if the filling is found to be too high the

overplus should be carefully removed with sharp instruments of proper shape, and with due care that the margins are not disturbed.]

Cement is mixed after the tooth is prepared and dry. It is then immediately pressed into the cavity, closely into position, and the surfaces smoothed. The mass is generally hardened before the smoothing is completed. As the burnishing instruments easily stick to the cement, they should be slightly oiled to prevent this.

Gutta-percha is introduced in a warm state, as otherwise it is not soft, and is used in small pieces, like amalgam. Its surface is worked with a slightly warmed burnisher.

Occasionally there will be seen fillings in adjoining proximal cavities, which extend from one tooth into the other. Such fillings are almost invariably bad. As every tooth moves in its alveolus during mastication, if ever so slightly, it is a natural consequence that in one tooth or the other the filling must become loosened.

CHAPTER XI.

EXTRACTION.

Indications Justifying the Operation.

If the recommendations given in previous chapters are observed, the extraction of teeth need seldom be resorted to. The negligence of patients, and the fear of dental operations, is generally the reason why defective teeth are so frequently permitted to remain in the mouth, until the pain and diseased conditions reach such a state, that extraction must be resorted to. The pathological conditions that make extraction especially necessary are principally diseases of the jaws, caused by gangrene of the dental pulp, alveolar or maxillary osteo-periostitis, and fistula of the jaw, tooth, or cheek. Aside from these reasons, there are occasional instances in which indications exist for the extraction of the teeth, even in mouths receiving the most thorough care of the teeth. During the eruption of the permanent teeth the loose temporary ones, whose roots have been resorbed in a normal manner, must be removed sometimes by the operator. But if the erupting tooth makes its appearance in a wrong position, in which resorption of the root of the temporary tooth is interrupted, the extraction of the temporary tooth by the physician or dentist is unavoidable.

Of the permanent teeth perfectly healthy ones must be extracted occasionally, and this is done in those cases in which the relative proportion between the jaw and the teeth is unfavorable, and hence all the teeth do not find space within the arch. Either a diseased molar on each side, a bicuspid or a cuspid, according to circumstances, should be extracted. Supernumary teeth also should be extracted if they occasion a deformity or cause annoyance during speech.

The first molar is frequently extracted even when it is possible to save it by filling; this is done, first, for the purpose of securing more space for the anterior teeth and later for the third molar; second, because its retention in good order for a number of years is

uncertain and very difficult. The third molars of the lower jaw must be removed sometimes before they have entirely erupted through the gums, because their eruption causes long continued difficulty. The third molars of the upper jaw are less frequently the cause of painful dentition. Sometimes they face toward the cheek so abnormally that they cause much annoyance, and must be extracted. Without special negligence, in consequence of pyorrhœa alveolaris sometimes the extraction of all the teeth is necessary. During senile atrophy of the alveolar process, the removal of the loosened teeth occasionally demands the skill of the operator.

The extraction of the third molars is sometimes advisable, but not under all circumstances essential. If they are decayed on the buccal or distal surfaces, so that filling would be fraught with much difficulty on account of the unfavorable position of the cavity, extraction may be considered advisable, because these teeth are often not very useful in mastication. For any other molar, extraction is only justifiable if the tooth is painful, or if its antagonist is missing. Especially in those cases where the patient is unable to pay (paupers) for the proper filling of these teeth, may extraction be resorted to.

Care should be taken not to be too hasty in extracting the first tooth from a perfect arch. If the arch is still unbroken, the loss of a single tooth is proportionately great. As all teeth except the lower central incisors have normally two antagonists in articulation the extraction of a single tooth places two others partially without function. At a later period the adjoining teeth become irregular, by gradually leaning into the space. Even if on each side but one of the molars is missing the surface of mastication is considerably lessened.

Extracting Instruments.

Instruments for the extraction of teeth consist of at least eight pairs of forceps and one elevator. The following forceps are the most useful:

A Cohen's so-called Universal Forceps (See Fig. 29) is used for the extraction of all single-rooted teeth, the upper and lower incisors, cuspids and bicuspids. The lower incisors, however, are frequently so narrow, or are so close together that a smaller pair of forceps is necessary; for these a common root forceps may be used. The third

molars, especially if they are of a small size, can sometimes be extracted with the Cohen forceps. The beaks are slender and can be pushed under the gum with ease, their inner surfaces are roughened so that the instrument does not readily slip from a root which it has grasped. The curvature of the beaks with the handle is at such an angle (about 135 degrees) that it may be used for the lower teeth as well as for the upper. Cohen's forceps is entirely excluded from use on molars.



FIG. 29.
Cohen's Forceps.

[It is much more convenient to use two pairs of forceps for these purposes, one for the upper and one for the lower teeth. Especially is a straight forceps, or one that is slightly curved flatwise the beaks, better for the upper incisors and bicuspids. The lower incisors are very readily extracted by forceps curved at the beak only, straight handles, which also serve well for the extraction of the lower bicuspids.]

The second instrument is for the lower right and left molars. (See Fig. 30.) It is bent at almost a right angle (110 degrees). Its beaks have on each side anteriorly and posteriorly a groove for the anterior and posterior root. Between the grooves is a point which passes between the two roots of the tooth.

The upper molars have three roots, two externally toward the cheek, and one internally toward the palate. The forceps necessary for the extraction of these teeth must have on the external beak two depressions, and on the internal but one. Hence two separate instruments are necessary for the extraction of upper molars, one for the right side and one for the left. (See Figs. 31 and 32.)

Were but one instrument used, it would not fit in all cases. If the instrument intended for the right side should be used on the left, the point which is intended to pass on the right side between the two buccal roots, would, on the left side touch the convexity of the palatal root, while the borders of the beak intended for one root would come in contact with the buccal roots.

The upper molars are frequently rhomboid in shape, and are in such a position, that the buccal mesial border is very prominent, while the buccal distal is stunted. Corresponding with this condition, the anterior buccal root is much stronger than the posterior.

Hence the depressions in the beak for the anterior root should be deeper than for the posterior; otherwise the latter would be caught with it and the forceps would glide off in a backward direction.

The curvature of the handle to the beaks is at about 150 degrees. For the smaller third molars with rudimentary roots, the molar forceps are often unsuitable; these teeth can be generally removed more readily with Cohen's forceps. But if it is desirable in all cases to operate with tolerable ease and certainty, it is best to use a bayonet-shaped forceps with a single wide depression for the extraction of upper third molars, which are located far back in the mouth. (See Fig. 33.)

For the lower third molars the beaks must be somewhat wider, but shorter, so the tooth may be reached even when the jaws cannot be opened very far. The curvature of the handle to the short beaks must be almost a right angle. (See Fig. 34.)

For the roots of narrow teeth a single forceps will answer, if it is bent at an angle of about 135 degrees, so that it may be used in the upper as well as the lower jaw, if its beaks are narrow. (See Fig. 35.)

[The extraction of roots is occasionally very troublesome, and with a single forceps, positions will be found in which the grasping of a root will be almost impossible. Especially in the lower jaw, roots will be found posterior to teeth with long crowns that cannot be reached with reasonable ease unless the curve of the beaks of the forceps approach a right angle. Such a curvature makes the use of the instrument in the upper jaw almost impossible. Therefore two root forceps are very desirable. That for the lower jaw should be bent nearly at right angles with rather narrow and long beaks and that for the upper jaw should be of the bayonet-shape (the shape recommended for upper third molars) with narrow beaks. These will enable one to operate with ease in any position.]

Roots can be grasped with this instrument properly only when a few mm. still project over the firm border of the alveolus, or if the alveolar border has become flexible from inflammation. If neither is the case, as for instance when a tooth is firm in its alveolus, or if the root is broken even with the alveolar border, and it is absolutely necessary to extract it, a resection or alveolar process forceps is necessary. (See Fig. 36.)

The borders of the beaks of this instrument are sharp, and with

it both the gums and alveolus can be cut through without crushing, and at the same instant the root is grasped. The instrument should be bent at about 135 degrees, if it is intended to use it in the upper as well as the lower jaw.

For the extraction of splinters of the temporary teeth as well as for the roots of the permanent teeth an elevator is necessary. The lower third molars, in case of great stiffness of the jaws, are removed with Lecluse's elevator, which is a spade-like instrument. In addition to these instruments the specialist is in possession of a large number of others that are very useful in special cases. Thus, for instance, there are forceps for children's teeth, which are smaller than the usual instrument. These, however, can be entirely replaced by the root forceps, Cohen's, and perhaps the upper and the lower third molar forceps, with which the temporary molars can be extracted. The bayonet-shaped forceps are very advantageous for the upper jaw. There are also instruments with wedge-shaped beaks, which have the effect of throwing out the root when introduced between it and the alveolus. The practicing physician can do without these special instruments.

The American forceps are curved at various angles, without being of special advantage. In addition to this the American forceps also differ in the joint, which is so constructed that one branch of the instrument passes through the other [as shown in the illustrations], while in the English and German instruments they are simply laid one upon the other. The joints of the latter become loosened sooner than those supplied with the American joints.

The key may be dispensed with, as may many special forms of forceps. In some cases, however, the operation may be performed with less injury with the key than with the forceps. They are the cases in which on one side the root is decayed and broken away below the alveolar border, while on the other side sufficient projects, so that the beak of the key can grasp it. If forceps were used in such a case, they would have to be provided with cutting beaks for resection, and this is a far more extensive operation than the extraction with the key, the instrument being applied on the side where the root is broken away, and the fulcrum would be properly cushioned and placed on the gum.

The Operation.

Before deciding to extract, one should be satisfied that the operation is necessary, or at least advisable. The operator should be positive that the tooth which the patient claims to be the painful one, is really the cause of pain (see previous chapters). If extraction is decided upon, the proper instrument should be selected and used without any unnecessary loss of time.

During the application of the instrument the left hand should hold the lips and tongue out of the way, in order that the tooth to be extracted may be seen distinctly, and that it can be readily reached with the instrument. Otherwise the latter should be guided and held by the right hand alone. This may be learned most readily by practicing the following grasp of the instrument. With the entire hand first the right handle is grasped, then the third and small fingers are passed over the other handle, while the forefinger and second finger are placed between the two handles. These two last named fingers are placed in that position for the purpose of preventing the tooth from being crushed by the instrument, but this is not prevented by the fingers, even if they are insensitive to pain from the pressure of the two handles; they should be used for the purpose of opening and closing the beaks of the forceps at will, while they are being applied. This is done generally by the movement of the middle and the third finger between which one of the handles is held while the other handle is between the thumb and forefinger. The back of the hand during these movements in grasping the upper teeth faces downward, while in the application of the forceps to the lower teeth, the back of the hand faces upward.

After the forceps are applied, they are carefully and firmly pressed up underneath the free margin of the gum, so that the roots of the tooth may be grasped. In the extraction of upper teeth the ends of the handles are firmly pressed against the hollow of the hand, while at the same time the left arm of the operator steadies and firmly holds the head of the patient in position against his breast. In lower teeth the left hand of the operator may be released from holding the soft parts, and used to press the forceps deep under the gums, and to steady the lower jaw by holding it between the thumb, which is placed upon the teeth, and the other fingers, which are passed beneath the borders of the jaw.

The tooth having thus been firmly grasped, the second part of

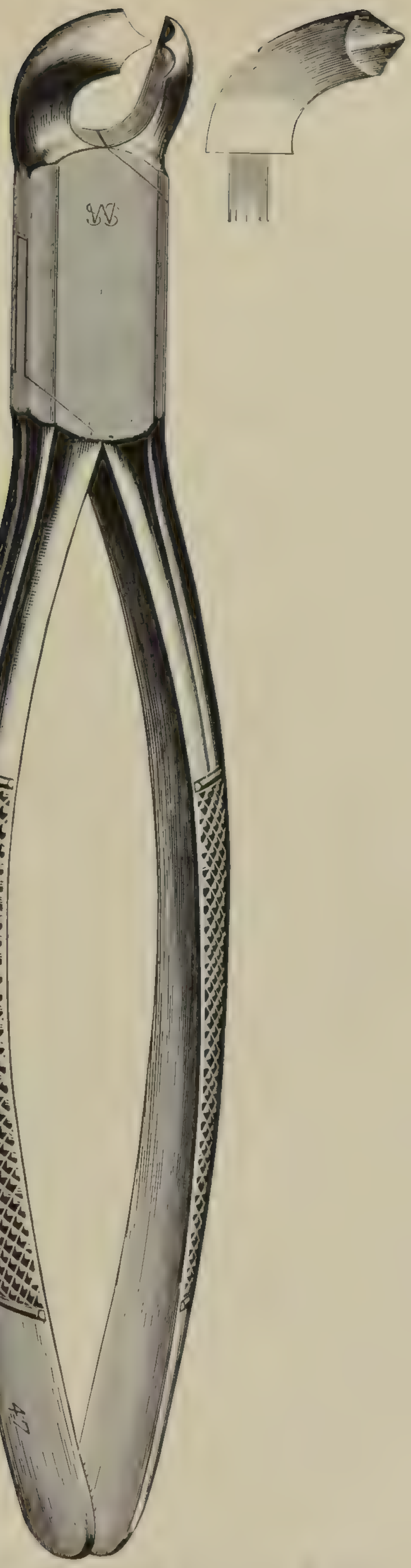


FIG. 30—*Forceps for the Lower Molars.**

* The cuts of the forceps of German manufacture, as illustrated in the original wor , are replaced in this translation by cuts of American instruments.

the operation, loosening the tooth from the alveolus, commences. Both the fingers used while applying the forceps between the arms of the handle, are allowed to pass around one of the arms in order that the forceps may be grasped with the entire hand. While this is being done care should be taken not to permit the instrument to move from the tooth. Some operators retain the index finger between the two arms of the instrument for the purpose of preventing the tooth from being crushed. This result is not gained by it, however; on the contrary one is less liable to operate skilfully if the finger is between the two closed arms, and he would be more likely to cause fracture of the tooth. The loosening of the tooth from the alveolus is secured by twisting and oscillating movements, which are exerted by the forceps firmly held upon the tooth. This causes an enlargement of the alveolus as well, and in the third part of the operation, the tooth is easily removed.

The upper incisors and cuspids can be readily extracted with Cohen's forceps (a straight handled instrument is somewhat more convenient but can be perfectly well dispensed with). As the roots of these teeth are round and but very little curved, their connection with the alveolus is easily broken by a rotary movement. A more marked expansion of the alveolus is generally unnecessary, as the conical roots are readily removed as soon as the rotary motion has broken the connection between the root and alveolus. If the root, however, is somewhat flattened and very long, as is often the case with the cuspids, or when it is markedly curved, in the effort to rotate it will be discovered that there is not the desired flexibility; sometimes the instrument will move around on the tooth. In these cases the rotary movement should be changed into an oscillating one; this is done by powerfully, yet not suddenly, pressing the tooth from the labial to the lingual side and the reverse, permitting the pressure to become gradually more powerful. Generally a single such oscillating movement will suffice, but occasionally it must be repeated.

Roots of the incisors are extracted in the same manner, but generally the root forceps are more convenient for this purpose, because the root can be grasped farther up. If the operation cannot be performed with this instrument, which scarcely occurs in hundreds of cases with these teeth, the last refuge is in resorting to the alveolar process forceps.

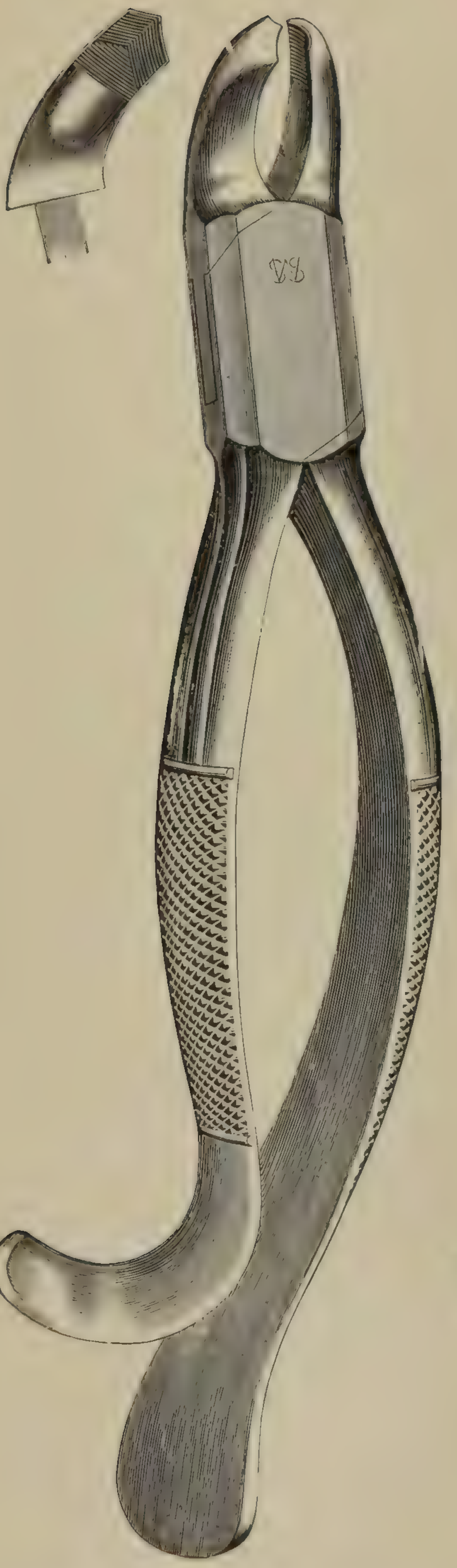


Fig. 31.
Forceps for the Right Upper Molars.

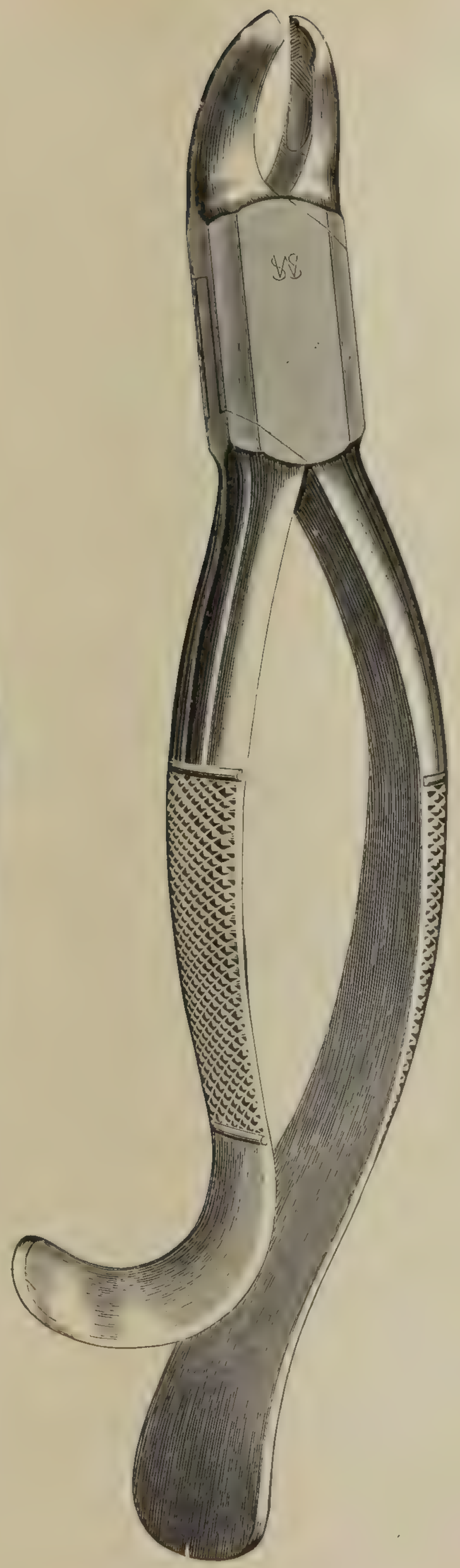


Fig. 32.
Forceps for the Left Upper Molars.

Sometimes in children, cuspids are erupted tolerably high up on the anterior surface of the alveolar process, and these must be extracted before their entire crown has appeared through the gum. In these cases the root forceps can be applied on the approximal sides instead of the labial and lingual. The beaks of the forceps can be pushed high up and the rotary power applied.

Supernumerary teeth frequently occur in the locality of the incisors; they must also be extracted generally with the root forceps, as there is not sufficient room for a wider instrument. Slipping a rubber ring on the tooth, which is intended to draw itself upon the conical root toward the apex, and thus cause a loosening of the tooth, a procedure which has been recommended by some, I have not had occasion to resort to in my practice.

The temporary cuspids and incisors are readily extracted with Cohen's or the root forceps. If these teeth have decayed early, before the pulp has been reduced to its normal size, and before the root is entirely formed, sometimes only a very frail thin shell will be found to require removal. They must be grasped very carefully, as they are readily crushed. Sometimes the elevator must be used for these splinters. It is also used for the extraction of such roots of temporary teeth, whose apex has perforated the gums (See page 39). After dividing the gums, the beak of the elevator is placed under the point of the root, and it is pushed out toward the lip.

Crowns of temporary teeth whose roots are entirely resorbed can be separated from the gums as a general rule with ease, by simply inverting them by a rapid pressure of the thumbs toward the lip. But if the tooth still retains some firmness, it is best to use the forceps, as a failure of the operation by applying simply the pressure of the thumb, frightens the child from the operation of the forceps which now has become necessary.

The upper bicuspids have broad roots whose broad surfaces correspond to the proximal sides. In addition, this surface has a trough-shaped concavity from below upward, so that a cross-section of the root appears biscuit-shaped. In the first bicuspid this curve is so deep that the middle substance disappears, and practically there are two roots, which are generally very thin toward their apex and diverge. According to statistics that I have collected, this occurs in about 70 per cent. of cases. If the root is thus formed, rotation of the tooth would not readily cause the desired loosening,



Fig. 33.
Forceps for the Upper Third Molars.

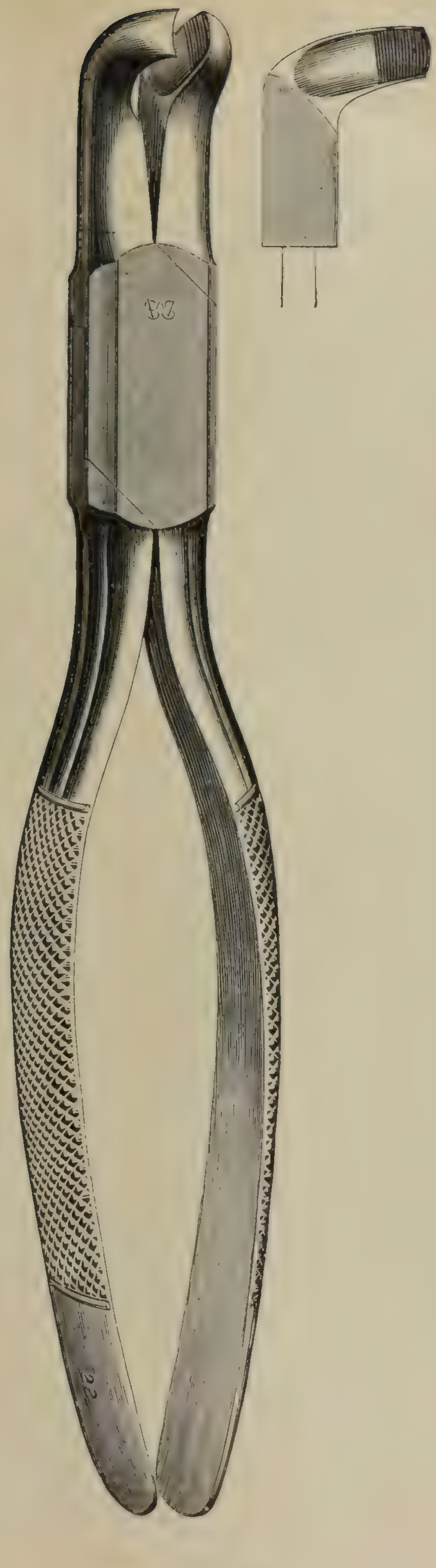


Fig. 34.
Forceps for the Lower Third Molars.

and hence the premolars must be luxated by oscillating, first toward the buccal and then toward the lingual side. Although instruments are made specially for these teeth, Cohen's forceps are generally practicable. It requires some practice to understand and distinguish the pressure to be applied to enlarge the alveolus from the pressure exerted by the beaks upon the tooth. The bicuspids are especially likely to be fractured easily if the pressure of the beaks is powerful, as these teeth are very thin at the neck. One must acquire the habit of being able to hold the instrument on the tooth loosely, without compressing it, and nevertheless to be able to apply sufficient force sideways, to enlarge the alveolus, that the root may be removed. The beginner most frequently fractures bicuspids, the skillful practitioner seldom. Frequently a small piece from the two weak roots of the bicuspids is broken and remains.

If the tooth is destroyed as far as the alveolar border, the root forceps or alveolar process forceps should be resorted to, and pressed up as far as possible. The latter are often more useful for the bicuspids than for any other class of teeth.

In the temporary set, the places of the bicuspids are filled by teeth having three roots. The first one is much smaller than the second, the latter having almost the size of a permanent molar. As a general rule only such temporary teeth require extraction the greater portion of whose roots have been absorbed, or when alveolar periostitis has resulted as a consequence of septic destruction of the pulp. In either case, extraction is not difficult. For the removal of the first temporary molar Cohen's forceps are used, and for the second either the same forceps as is used for the extraction of permanent molars, or that intended for the upper third molars.

If tooth-ache is caused in these teeth by pulpitis, it is not generally best to extract the teeth, but to retain them for several years. When removal is decided upon, it is essential to operate carefully, as a fracture may readily result, because the alveolar border does not give as when affected by periostitis; it encircles closely and firmly the thin spreading roots of these teeth.

Remnants of the roots of temporary molars require extraction when the adjoining permanent tooth has erupted, or when they perforate the gums, or have caused inflammation of the alveolar process. In all these cases the roots are readily removed by the use of the root forceps or the elevator.

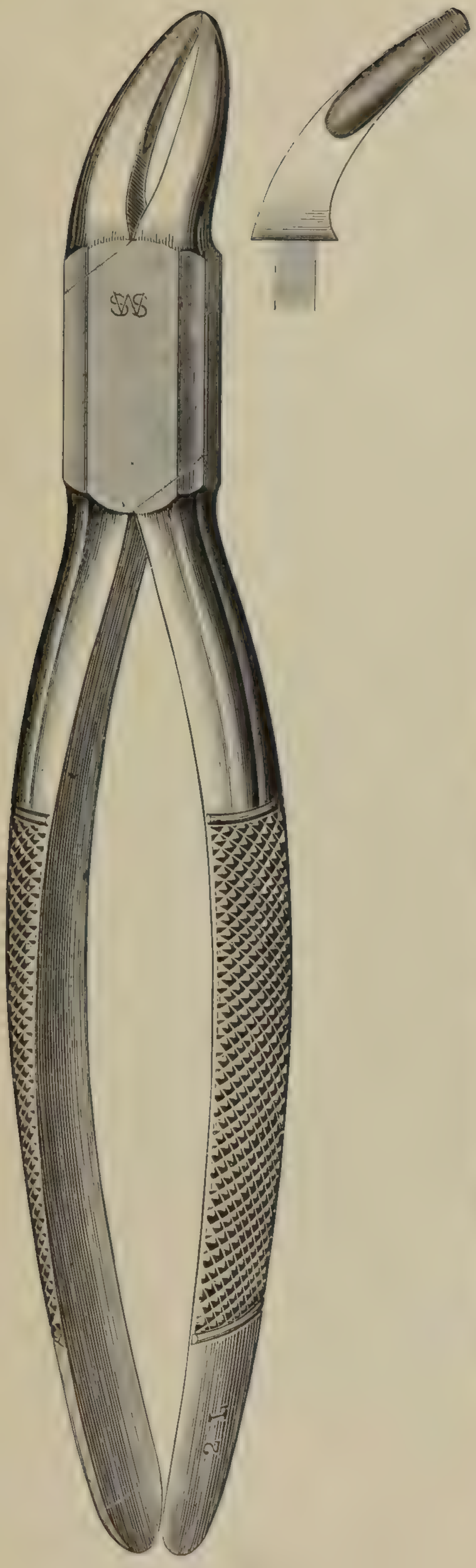


Fig. 35.
Root Forceps.

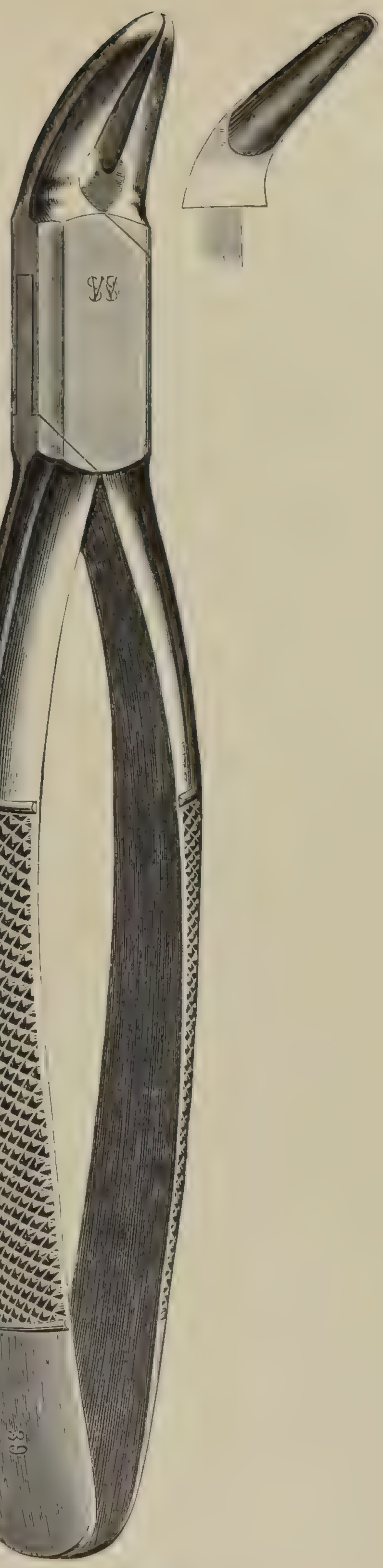


Fig. 36.
Alveolar Cutting Forceps.

The upper permanent molars are the most difficult to grasp, because they become smaller posteriorly, and the forceps readily slip backward. In order to prevent this, the handles should be pressed downward and the beaks applied from backward and downward in a position pressing it upward and forward. In order to luxate these three-rooted teeth, the first force should be applied outward, toward the cheek, in the direction of the inner angle of the eye.

The oscillating movements are exerted not by the humero-ulnar joint nor by the wrist joint, but in the radio-ulnar joint. The twisting movement of the hand gradually assumes an oscillating movement on the tooth. The pressure should be applied outward in the direction mentioned, because the outer alveolar wall is much weaker than the inner, and hence more readily yielding. If the pressure is not exerted in that direction, and toward the inner angle of the eye, but more toward the ear, then the outer alveolar wall is not pressed upon perpendicularly (at a right angle) but at an obtuse angle, and thus a part of the force is lost; hence the operation is made more difficult than necessary.

If the crowns of these molars are destroyed, the roots that may be present are not unusually difficult to remove. The cause leading to extraction, as a rule, is inflammation of the root-membrane, and when such is the case the surrounding bone is sufficiently flexible to be readily entered by the root forceps. It is advisable to grasp first the anterior buccal root, then the palatal and finally the posterior buccal root. In removing roots of the second molar it should be remembered that now and then the posterior root is united with the palatal.

The use of the key is advantageous in very few cases of extraction of these teeth. It occurs sometimes that on the buccal side both of the roots are still united, while on the palatal side the crown is destroyed and broken up to and underneath the margin of the gum, and in such a case extraction with the key is less damaging than with the alveolar process forceps. The fulcrum is thoroughly cushioned and applied on the gum on the palatal side of the tooth, the beak is placed on the buccal side. It is firmly held with one hand against the root, while with the other the key is slowly turned. If this movement is made rapidly the alveolar process may be fractured, and infrequently the alveolar wall of the adjoining

teeth is broken at the same time. But if the pressure and the force of drawing, are permitted to exert themselves gradually, the danger of fracture of the alveolar process is exceedingly slight. The pressure of the fulcrum on the gum is painful only when the cushion is not sufficiently thick, and when the tooth is very firm in its socket.

The alveolar process forceps are used as seldom for the extraction of the upper molars as the key itself. If periostitis necessitates extraction, as a general rule the ordinary forceps or the root forceps will answer the purpose, but if pulpitis is the cause, the tooth is generally strong enough to be removed with the ordinary forceps. The alveolar process forceps should be used in those cases in which the crown has been fractured by using the ordinary instrument, and the pulp failed to be removed. If the latter came away with portions of the fractured tooth, the remainder may be permitted to remain for several years.

[I have seen so many cases of distressing alveolar abscess occurring at the apices of roots left in their alveoli after breakage, that I feel disposed to insist that such roots be removed. There are undoubtedly cases in which this is not advisable on account of the condition of the patient, or possibly on account of the difficulties of the case. But such are certainly rare. If the case is one of pulpitis, and the pulp has been drawn from its root canal, the pain is pretty certain to be relieved, but if the case be one of beginning apical pericementitis it is likely to become worse.]

The upper third molars are the most difficult to grasp, but the least difficult to extract. If the mouth is not opened very far, so that the coronoid process of the lower jaw does not lessen the room required for the instrument, the tooth can generally be grasped with a bayonet-shaped forceps, and with some practice it is readily removed, even though but little of the crown is visible, and the second molar immediately in front of it is very long. Care should be taken, if the tooth is broken very far up, that the instrument is applied to a sufficient depth on the outer surface. After the forceps is once applied, it can be pushed higher up than in the case of any other teeth. The alveoli of the upper third molars seem to give more readily than those of any other teeth. The alveolar cutting forceps need not therefore be resorted to in extracting upper third molars. In about seven hundred cases of third molar teeth that I

have extracted, I have not found their use necessary. Fracture occurs very seldom if the tooth has been properly grasped, because the roots are generally rudimentary. The movement for luxating the tooth should be exerted toward the buccal side.

The lower third molars are usually grasped without any difficulty. When they are the cause of inflammation of the alveolar process, the muscles of mastication are usually exceedingly infiltrated, and in consequence of the inability of the patient to open the mouth it is very difficult to introduce the instrument between the upper and lower teeth and to pass it along the teeth to the third molar. If the swelling is so diffuse that the mouth cannot be sufficiently opened for the usual instrument, a Lecluse elevator should be resorted to; this is passed between the second and third molars, then pressed deep and firm between the alveolar wall and the latter tooth, and followed by a powerful elevating movement. As general inflammation of the alveolar process about the third molar is the cause of the closure of the jaws, and as the inflammation has somewhat loosened the tooth, extraction with the elevator is usually attended with success. If inflammation is absent, or only slight, and the forceps can be used, they should be preferred to the elevator, because the use of the latter is more painful than the former. I have found occasion to use the elevator in extracting lower wisdom teeth in about one-third per cent. of the cases only. There are operators, however, in whose hands this instrument finds more favor.

Luxation of the lower third molar with the forceps is not very difficult, if the oscillating movement is exerted in a labial and lingual direction. The principal movement of the arm is again in the radio-ulnar joint. Sometimes the lower third molars are very firm in their socket because the roots are occasionally very much curved. This may result in fracture of the roots, an accident which in this position is so much more unpleasant because resection is almost impossible. The alveolar process about the third molars is so low down that an extensive injury is dangerous, if the alveolar cutting forceps are used. If, therefore, a periostitis has necessitated the attempted extraction, fracture having taken place, the operations should be limited to the removal of the pulp (if it was not removed with the crown), whereupon the pain generally disappears. If in course of years, or even, as is often the case, after a few months,

inflammation of the root membrane results, the extraction in consequence of that inflammation and looseness of the roots is less difficult, and may be performed either with the root forceps or the elevator.

[In case a third molar is fractured as low as the buccal alveolar border, it should, if possible, be at once removed with the Physic's forceps or elevator (similar to the Lecluse instrument). In case such a fractured tooth is left, alveolar abscess is liable to occur, and great swelling, and the most intense suffering result. True, if the patient escapes this, the tooth may be removed much more easily some months hence, but the danger of inflammation is too great to be risked except under the most necessary conditions. The difficulty of using the ordinary forceps for the removal of this tooth after breakage to a level with the border of the alveolar process arises from the fact that this tooth is placed in an alveolus upon the lingual border, often built out upon the lingual aspect of the bone, instead of an alveolus formed on the upper surface of the bone as is the case with the other teeth. Therefore, the bone proper, rather than the alveolar process, lies on its buccal side and is often as high, or higher, than the neck of the tooth, and a quarter of an inch or more in thickness. Of course this cannot be cut through with the ordinary alveolar cutting forceps. And unless the peridental membrane is thick enough so that the blade of the forceps can be started down between the root of the tooth and the bone of the buccal side, the forceps cannot be used. In such cases the point of the buccal blade of the Physic's forceps (the blades are alike and the buccal blade will be the one or the other as the tooth is on this side or that) is forced down into the buccal angle between the second molar and the wisdom tooth as far as possible while the blades are yet wide open and the back of the forceps looking inward toward the roof of the mouth, the handles being held as high as practicable. Now, while holding the buccal blade firmly seated in its position and without otherwise changing the position of the forceps, the blades are firmly closed by which the lingual blade cuts through the gum tissue and lingual alveolar process, and passes well in between the root of the third molar and that of the second molar. Now the handle of the forceps is just a little depressed, until a pry upon the root is felt, and then moved firmly toward the side upon which the tooth is situated so that the tooth will be thrown backward, inward and upward or toward the soft palate. The movement of the hand in the latter

part of the operation is nearly in a line drawn from the outer angle of the eye of the opposite side, crossing the upper lip at its centre. By this movement the tooth is thrown against the weakest portion of its alveolus, the posterior lingual, and is displaced with the minimum of force. This extraction should never be done by exerting the force backward and upward, for the reason that the bone is usually very hard and firm behind the buccal, distal angle of the tooth, and great force is required to remove it in that direction. If the force is applied in such a way as to force the tooth partially toward the buccal side, there is danger that the jaw itself will break before the tooth will be displaced.]

The use of the key for the lower third molars is contra-indicated, as at their alveoli the internal oblique line produces a prominent ridge, which disappears immediately behind the tooth. This protuberance is fractured very easily under the pressure of the fulcrum.

The lower molars have two roots, one anterior and one posterior. But one pair of forceps is necessary for both sides. This instrument has on each beak corresponding with the roots of the teeth an anterior and posterior depression, between the depressions a point, which passes between the roots. These teeth are loosened in the same manner as the third molars.

If a lower molar is destroyed on one side as far as below the alveolar border, while on the other side there is still a firm portion of the tooth above the gum-line, the key may be used; its hook should catch the outer border while the fulcrum is applied on the gum covering the other side of the tooth. But the use of the key is limited to about one or two per cent. of all the cases.

Less frequently the roots of the second molars are united, so that the usual forceps cannot readily grasp them, but instead there is a disposition of the instrument to slip backward. In these cases the forceps intended for extraction of the lower third molars should be used.

The roots of lower molars are easily removed, but the beginner makes the error of failing to open the beaks to a sufficient extent when attempting to grasp the root. It should be remembered that the root is about as wide as the adjoining molar at its neck. There is no objection to the use of the alveolar cutting forceps for the extraction of the separate roots of molars when they are firmly imbedded in the jaw.

Sometimes the second molar leans forward; this is the case when the first molar has been missing for some time. In these cases the forceps previously described do not readily grasp the tooth, because in attempting to do so the handles touch the lower incisors before the anterior depressions of the beak can grasp the anterior root. For these cases a so-called hawk-bill forceps is to be used. In these forceps the beaks are placed transversely to the handles. Hence they do not open and close laterally but antero-posteriorly. The operator takes his position at the side of the patient when using these forceps, but in the extraction of a left molar his position is on the left side of the patient, while in all other cases he stands to the right and slightly in front of the patient. In a simple line of instruments the hawk-bill forceps may be dispensed with, and teeth occupying these positions are extracted with the usual forceps in the best possible manner; but if that instrument does not sufficiently well grasp the tooth, the instrument intended for third molars, or the key, may be resorted to.

As a general rule the lower molars are more readily grasped than the upper, but they are firmer in the jaw, although supplied with only two roots. A more pronounced curvature of their roots and a greater unevenness of their surface is the reason.

The lower bicuspids have but one root. They are readily grasped with Cohen's forceps, but their luxation is sometimes difficult because their roots are very long.

[Many operators prefer a forceps with straight handles, the beaks of which are bent at right angles or nearly so for these teeth.]

The temporary tooth that occupies the position of the second bicuspid is a molar, and is extracted with the forceps intended for permanent molars, but as this instrument is sometimes too large the third molar forceps may be employed in its extraction.

The temporary premolar (first temporary molar), which has two roots, and which occupies the position of the first permanent bicuspid, is too small for the third molar forceps, but is readily removed with Cohen's forceps. The lower cuspids and incisors can also be removed with Cohen's forceps, and only where the teeth are crowded or narrow a smaller instrument is resorted to, and this is generally a root forceps. This instrument is also used for the extraction of the lower temporary incisors. As the

permanent lower incisors are not round but flat, the movements for their luxation should be lingually and labially oscillating. These teeth are least liable to decay, and hence require extraction least frequently.

Healing of wounds.—After the extraction of a tooth the alveolus is filled with a blood-clot. Within it, embryonal cells soon appear, and the thrombus is gradually resorbed and replaced by a vascular granulating structure. At a later period the vessels become less numerous, bony spiculæ and trabeculæ appear in the structure, and gradually become more numerous. In the meanwhile the gums become contracted over the wound, the alveolar process is absorbed, and the walls approach each other. Under continued shrinkage in the depths of the alveolus, new spongy bone tissues develop, which become condensed upon its external surface, where the alveolar walls approach each other, and which change into a compact substance. The gums finally cover evenly the contracted parts.

Disinfection of Instruments.

After the extraction of teeth the instruments should be invariably cleansed; the beaks dipped in water, or water should be allowed to run over them. The forceps are then thoroughly dried and wiped with a towel, and finally the beaks are dipped in carbolized oil. The latter should contain a large percentage of carbolic acid, for a 10 per cent. solution was proven as long ago as 1865 by Lemaire, and recently again by the German Imperial Bureau of Health, to possess but slight disinfecting properties. For the last eight years I have been in the habit of using in my private practice, as well as in the Polyclinic a 33.33 per cent. carbolized oil. By the use of the carbolized oil the instruments are kept clean in two different ways. The physical property of the oil prevents a firm attachment of tartar, saliva or any other solid or liquid septic substance, and the carbolic acid contained in it also has a disinfecting property.

Cases in which the use of dental instruments have transferred septic or virulent substances from one person to another, and thus caused inoculation, are exceedingly rare; but they certainly will not occur if the instruments are disinfected in the manner just described.

General and Local Anæsthesia for Extraction of Teeth.

As the extraction of teeth is usually a painful operation, patients as a rule have fear of submitting to it, and hence postpone it as long as possible. For these reasons it is sometimes desirable to resort to narcosis, even in these short operations. When deep narcosis is not essential, as is generally the case in dental operations, ether and chloroform have proved comparatively dangerous. Nitrous oxide gas is less dangerous, but is of service only for short operations, and for them is of sufficient duration. It cannot be denied, according to reports in literature, that nine cases of death have occurred from the use of nitrous oxide, and that in some cases indications of poisoning, such as headache, excitement, trembling, insomnia, etc., have followed narcosis. On the other hand, against these few cases there are hundreds of thousands that are not followed by the slightest unfavorable consequences, though frequently the administration is very carelessly conducted. The most important point for obtaining good results and not dangerous narcosis consists in procuring pure nitrous oxide, and to administer it without interruption. The majority of dentists now procure it in a liquid form from such dentists as manufacture it in large quantities [in the United States, entirely from manufacturers of dental supplies], and thus by their experience and practice, a pure nitrous oxide is produced. It is manufactured by heating nitrate of ammonia. Water and nitrous oxide are the results according to the following formula: $NH_4NO_3 = N_2O + 2\,H_2O$. Under high pressure the nitrous oxide is liquified and passed into strong iron cylinders. In order to transform it into its gaseous state a rubber tube is attached to the opening on the cylinder; this connects with the gasometer or a rubber bag. With the vessel containing the gas there is connected another rubber tube leading to the mouth. At the end of this tube a mouth-piece is attached; this should be supplied with an air-cushion which surrounds the mouth and nose, preventing the introduction of atmospheric air. Some mouth-pieces are made in such manner that during the inhalation the nostrils must be closed by the fingers of the operator. Nitrous oxide is not administered like chloroform and other anæsthetics, with a mixture of air, but undiluted. Dilution with air retards narcosis very much, and sometimes makes success doubtful.

There are many gasometers in use that do not hold sufficient gas for one narcosis. The patient is not permitted to expire into the atmosphere but back into the gasometer. In the latter there is a netting attached, which has been soaked in a solution of caustic potash. The expired gases in passing through this netting are cleansed, by the solution of potash, of the expired carbonic acid gas, and thus the nitrous oxide is again in condition to be re-inspired. When given in this manner for the purpose of narcosis about seven litres of nitrous oxide are necessary, and according to those that are in the habit of resorting to the saving system, some of whom have administered the nitrous oxide more than ten thousand times, the effect is said to be as good as in those cases in which expiration into the air is permitted. It appears to me, however, that the use of the pure gas would be preferable; the necessity for a larger quantity should not be an objection. If pure gas is used for the purpose of perfect anæsthesia, on an average about 25 litres of gas are necessary (from 12 to 48). If narcosis is not produced rapidly (usually after one minute), and its effect does not also disappear more rapidly, the system of breathing into the gasometer may be exceedingly dangerous. In the short time, however, during which the re-inspiration of the gas takes place, the small quantity of carbonic gas that was not absorbed by the potash solution, and therefore re-inspired, as well as other gases of expiration, may not be hurtful. There are also certain contrivances on the mouth-piece that make it possible to permit the air of expiration to pass into the atmosphere or the gasometer, as desired.

About the administration of nitrous oxide there is nothing special to mention. The same care and caution should be observed as when chloroform is used. The patient may be placed in a sitting position in order that contraction of the muscles during the beginning of narcosis should not cause closure of the mouth; before administering the gas, a prop should be placed between the teeth of the patient. That atmospheric air should not be permitted to enter, has been previously mentioned. It may be stated that narcosis results more rapidly than when chloroform is used (within 40 to 80 seconds), and that frequently just before the completion of anæsthesia there is a rattling breathing. The cyanosis of the face is not of so much importance as in the use of chloroform narcosis.

Paul Bert's method, the breathing of nitrous oxide that has

been mixed with one-fifth of oxygen under high pressure, cannot be generally used on account of the inconvenience attending its administration; according to recent experiments the high pressure is not necessary, however. It appears at present as if the nitrous oxide and oxygen mixture would be the least dangerous narcotic.

As past experience has practically proved that none of the narcotics are absolutely safe, attention is continually drawn to the local anæsthetics. The ether spray was used long ago. A few years ago it was employed in the extraction of teeth according to the modified form of von Lesser. The effect of cold, even in the best cases, is unreliable. In pulpitis it is unbearable, and in alveolar periostitis the pressure of the platinum casket in which the ether is evaporated in von Lesser's apparatus also occasions severe pain. Therefore this apparatus may be used only in dental periostitis and a few other cases. Other remedies are also unreliable or even less effective than the application of cold. This is also true of cocaine, if it is simply applied externally and not injected. The injection of 0.03 gram cocaine into the gum near the tooth to be extracted, seems to materially lessen the pain of extraction.

Accidents and Unfavorable Consequences of Extraction.

The most frequent unpleasant accident in the extraction of teeth is the breaking of the tooth. Our instruments are now so constructed that this accident does not occur so very often. In some cases fracture is anticipated with tolerable certainty, and it may be desirable for the operator to inform the patient of the conditions; but the patient should not be frightened unnecessarily. A sympathizing operator may be often in a position to suppress a difficulty which he is able to anticipate. But in some cases it is impossible to know whether a tooth will break or not. Some teeth are very frail. Occasionally there may be exostosis of the roots, which may be a serious hindrance to extraction, and finally by the application of a great deal of force, the tooth breaks. Very divergent roots are liable to break. The patients are as a rule frightened when a tooth is broken, and are inclined to blame the operator. The knowledge that the most difficult part of the operation is now to follow, is the cause of the readily discernible displeasure of the patient. Not always, however, is it necessary to complete the operation immediately. It is certainly advisable if the extraction of the root is not

difficult; should it require the application of the alveolar process forceps, however, we generally recommend that the patient wait and learn whether the pain will not cease of itself or whether it cannot be allayed. In course of time the roots are gradually raised from the bone, and can be grasped with ease. Generally a cessation of pain may be expected after the fracture. The most frequent causes leading to extraction, and in which a fracture is liable to occur, is pulpitis and dental periostitis; in alveolar periostitis the alveolar process has been so rarefied by inflammation that extraction is not fraught with difficulty. In the first case the pain ceases when the pulp is removed, which usually occurs by the unintended fracture, as the forceps instead of grasping the crown generally grasps the roots. Should the pulp remain attached to the roots (I have observed this only in molars) it can be removed with a small sharp spoon-shaped excavator, after which a small quantity (perhaps 0.003 gram) of arsenious acid should be applied to the root portion of the pulp. This is held in its position by cotton dipped in sandarac varnish, which is pressed and smoothened against the gum with the damp finger. As a rule the cotton becomes entangled with the blood-clot so that the application will remain twenty-four hours.

[This practice should be adopted only in cases of the most urgent necessity, and when it is resorted to the utmost care should be exercised in placing the arsenious acid. In such positions it is exceedingly liable to be moved so as to come in contact with the gums and do serious mischief, especially if too great a quantity should be used. In any case, when a tooth is to be extracted, a suitable root forceps should be laid at the hand of the operator ready for instant use, so that in the event of breakage it can be at once applied. If this is regularly practiced the operator will eventually become so skillful in the handling of fractured roots that he will very generally be able to remove them before the patient is fully aware that a breakage has occurred, and very rarely indeed will he find it necessary to leave a root for the most timid patient. The management of fractured roots, or the extraction of teeth for that matter, is to be learned only by close study of the subject in detail, in connection with continuous practice. The positions of the teeth of patients that come under our care should be studied with reference to this operation, not only in those who apply for the

operation of extraction, but others as well; the form of the tooth, crown, neck, and root, and especially the forms of the roots; the form of the alveolar process, its thickness, its firmness, the proportion of the root of the tooth that is imbedded within the alveolus; in fact every possible detail should receive constant attention and earnest study. In no other way can the operator be ready on the instant to apply the right instrument in the right way in the individual case of breakage, and have out the roots so quickly that the patient has practically known but one shock of pain. An operator should *never* be under the necessity of *selecting* an instrument with which to remove a root, after the fracture of a tooth. It should be ready at his hand.]

In dental periostitis the discontinuance of the pain after fracture is accounted for on other grounds. This disease, as we know, is the result of irritation caused by the septic mass in the pulp canal. When the pulp is gangrenous, gases of decomposition are produced, and their expansion causes a pressure of the decomposed fluids through the dental foramen and upon the periosteum. If the crown of the tooth is fractured, these fluids of decomposition receive an outlet, and the cause of the inflammation disappears as the result. It is best when the extraction of roots affected by dental periostitis is not completed, to remove the gangrenous portions of the pulp from the root canals with barbed broaches (Fig. 37), but in so doing care should be taken that the point of the instrument should not be caught at the dental foramen and possibly close it with gangrenous substances.



FIG. 37.
Broaches.

The luxation of an adjoining tooth may happen to the beginner. In order to prevent this the tooth to be extracted should never be out of the operator's sight during any of the movements. Frequently a quiet and certain operation is hindered or sometimes made entirely impossible, by the restlessness of the patient. If such a luxation occurs, or if a sound tooth should be extracted, it should be immediately pressed firmly into its socket, and an application of cold water recommended. These replaced or replanted teeth become re-attached as a general rule.

Fracture of the alveolar process occurs seldom. It was very common when the key was the universal instrument. With the

forceps it is not easy to fracture parts of the alveolar lamella. In using them, the alveoli are expanded gradually, so that finally curved and divergent roots are easily extracted. An exception to this rule is found in upper molars, on whose buccal surface the alveolar lamella is very thin and frequently breaks. But this is of no consequence; by the application of reasonable pressure with both of the index fingers over the gum, bringing the fingers toward one another, the borders of the fractured bone are brought in close contact. In exceptional cases during the extraction of lower molars the alveolar wall may be broken, if the tooth is very firmly attached. The fractured parts can be replaced in the same manner.

At the present time, fracture of the jaw during extraction would be considered a curiosity.

Displacement of the lower jaw may occur during extraction as well as during other operations about the teeth. I have seen it occur during examination. The method of replacement has been stated in a previous chapter.

If the extraction of a tooth is very difficult, the adjoining tissues, especially that portion of the alveolo-dental periosteum which has remained in the socket, is subjected to powerful pressure, which results in necrosis of small portions of this membrane. Hence there arises inflammation of the alveolar process of the socket. The inflammation may be especially severe if the cause of extraction was dental periostitis accompanied with pus, so that pus has been driven into the surrounding bone tissue.

The treatment of such inflammation consists in rinsing the mouth with carbolized water and the daily repeated injection into the alveolus, of corrosive sublimate, one part in 3000 parts of water. The nozzle of the syringe should be held about one cm. from the alveolus. If the thrombus is septic, it is washed out by the stream from the syringe, but if firm, it should be permitted to remain. The thrombus should never be removed intentionally, because it is the best and safest protection against the entrance of injurious and especially septic substances. Nor should there ever be anything placed in the alveolus immediately after extraction; the most powerful antiseptic would be worthless until the next day.

Aside from succeeding inflammation of the alveolar process, the simple irritation of the gum may also cause pain in the socket. Sometimes the gums contract firmly over the free border of the

alveolus, and are continually irritated by its sharp edges. Gentle pressure of the finger applied upon the very tense gum causes severe pain. This condition is often observed after resections, or after injury of the alveolar border. To relieve the pain an incision into the border of the gum is sufficient.

[A very good plan of treatment in these cases, especially if it is a sharp corner of the process that is causing the irritation, is to hold a sharp chisel in just the right position and just at the right moment the assistant strikes it a smart blow with the mallet and the sharp corners of the bone are cut off instantly. This may be turned out or left to work its way to the surface; in either case the source of annoyance will be removed.]

The bleeding following the extraction of teeth is capillary, and generally ceases spontaneously. The patients may use water for the purpose of washing away the flowing blood. They should not be permitted to suck the cavity; some patients believe that they must suck out the blood, but this generally increases the flow. The wound should be given perfect rest, that the alveolus may be filled with a thrombus. As a general rule bleeding ceases after rinsing the mouth with cold water for five minutes. If it continues for a longer period, holding together the borders of the wound for half a minute with two fingers sometimes suffices to stop the flow. Occasionally secondary bleeding takes place, especially at night. The patient should therefore be recommended to compress the wound with the fingers in case bleeding should again commence. Acidulated water may also be used for rinsing the mouth. For stopping secondary bleeding from an extraction-wound the physician uses a tampon dipped in a solution of sesquichloride of iron. It is not sufficient to simply prescribe for the patient cotton dipped in the solution of iron, and recommend that he himself should place it in the wound; the tampon should be applied by the operator. It is my custom to dip a pellet of cotton the size of the crown of the tooth in a solution of chloride of iron, and to press it upon the wound. The blood-clot should not be removed from the alveolus for the purpose of introducing the tampon, but the pellet of cotton should be laid on the thrombus. The latter does not entirely close the cavity, and the object of the solution of iron with which the cotton has been moistened is to coagulate the blood that oozes from the alveolus. I hold the pellet of cotton for a period of from a half to one minute

with two fingers with a gentle pressure upon the wound. As a general rule this causes a cessation of the flow, but when it does not, the same procedure should be repeated with fresh pellets of cotton, several times, according to circumstances.

In place of the solution of sesquichloride of iron Prof. Hollaender recommends tannin, Dr. Busch chromic acid; and there are numerous other styptics that can be used, but the solution of iron is generally preferable.

[In cases in which bleeding after extraction is expected, and patients are occasionally found that are very fearful of such an occurrence, it is well to recommend that a finger, their own or that of a friend, be laid over the wound and held for half an hour. This will give the blood in the alveolus and in the wounded capillaries time to form a firm clot and is almost uniformly successful. Indeed half that time will suffice in most cases. There are, however, some anæmic individuals with whom the full half hour will be necessary. Plugging the alveoli with cotton or anything else than the normal blood clot should be avoided, indeed, strictly forbidden, for the reason that it is unnecessary and likely to do harm by causing subsequent inflammation and suppuration. In some exceedingly rare cases of arterial bleeding the plugging of the alveolus might be justifiable. I can remember having seen but two such in thirty years of practice.]

Arterial bleeding follows the extraction of teeth very rarely; I have not seen a single case in forty thousand extractions. Hitherto it has been observed after the extraction of lower molars by Hollaender and others, and after the extraction of an upper third molar by Busch. When the inframaxillary canal is situated unusually near to the roots of the teeth, the dental artery of the lower molars may be easily severed, close to the inferior alveolar artery, so that a thrombus does not readily form. Aneurisms also may be the cause of bleeding in these positions. At the upper third molar tooth, arterial bleeding may result only when extensive resection has been performed, so that the palatine artery has been injured near the point of its origin from the pterygoid artery.

[I have in one case seen the palatine artery wounded, evidently with the gum lancet while loosening the gum from an upper third molar. When I saw the case two days afterward arterial blood was escaping in definite pulsations, but a closer examination showed that

it was not from the alveolus, but from between the gums and the alveolar wall. It was then readily traced to the artery and as this was not easily taken up it was stopped with the actual cautery. The alveolus had been plugged with a view of stopping the bleeding, but with the effect of causing considerable inflammation.]

As a remedy for allaying arterial bleeding the tampon should be used in connection with styptics.

Syncope occurs, especially in weak anæmic persons, before as well as during examination or during the operation, and also after extraction. The patient is placed in a horizontal position, aqua ammonia is held near the nostrils, the face is sprinkled with cold water, [and plenty of fresh air is admitted to the patient].

Attacks of cramps sometimes occur during extraction of teeth in persons subject to them. But these cases are very rare.

Trismus, or lock-jaw, may occur as a result of the extraction of teeth as well as the result of other operations in the mouth, or even as the result of simple examination. The operator is in danger of having the fingers bitten and should therefore always have a mouth dilator at hand.

CHAPTER XII.

PROSTHESIS.

The treatment recommended in previous chapters for the salvation and retention of diseased teeth is generally neglected by a great many people; hence frequently in consequence of caries the teeth are entirely diseased even in comparatively young persons and they have to be replaced. As the result of senile atrophy of the alveolar processes, those teeth that are not previously destroyed by decay, are lost and require replacement. There are a great many persons for whom dental prosthesis is necessary.

It is well known that the products of mechanical dentistry have a favorable influence on the natural expression of the face, as well as the improvement of speech and of mastication. In those cases in which the artificial substitute lacks perfection for some reason, the cause may be negligence of the patient, or poor workmanship in the manufacture of the substitute, or in unusual difficulties of the case.

Preliminary Preparation of the Mouth.

It is very seldom that the mouth is in condition to receive an artificial substitute and to bear it with comfort. If the teeth have decayed away, the decayed remnants are often still present. On the other hand, if atrophy of the alveolar process is the cause of the loss of teeth, there may be a number of loose teeth in irregular positions within the mouth, which would have dropped out or been extracted in the near future. In both cases a substitute introduced without previous preparation would soon be useless. In order that it may be useful for a number of years and be satisfactory in every respect, diseased teeth or roots that may be present, as well as loose teeth, should be extracted before the denture is made.

We may consider it a rule that prior to the making of an artificial denture all decayed teeth should be filled and any loose teeth or roots whose crowns have decayed away should be extracted. After extraction, sufficient time should be allowed for healing and

complete shrinkage of the wounds, which requires, according to the size and number of the extracted teeth, from two to six months.

In practice objection is raised by the patient to such a procedure. Many persons that never do anything to preserve their teeth, entertain the idea that after the natural teeth are broken they can receive artificial ones. They expect that all this can be done without pain and as simply as the fitting of a coat, or any other garment. Often people do not prevent the destruction of their natural teeth because they have not the courage to consult the dentist, from the fear that the necessary operations may be painful. These patients are generally astonished, if the dentist recommends the extraction of the decayed roots before introducing an artificial piece.

It frequently happens that persons entertain the intention for months and even years to have an artificial substitute, but continually postpone the operation for one reason or another. An extraordinary festival which either requires their presence, or at which they expect to participate, makes it necessary to have a denture constructed immediately. This cannot be done readily if it is necessary to first extract a number of roots and await the healing of the parts. There are dentists (at least, patients tell us so,) that claim that the presence of the roots serves the purpose of a firmer basis for the denture. Such an opinion is based on very superficial observation. For patients it is sometimes convenient, hence these irrational methods are resorted to. Under any circumstances loose and periostitic roots must be removed.

Firmer roots (under urgent circumstances) may be permitted to remain, provided the dental canal is hermetically sealed before the introduction of the plate. This is generally done by properly filling the root in order to arrest its decay. In partial cases this may even be of advantage, because it would prevent the shrinkage resulting from atrophy of the alveolar process, thus resulting in the lengthening of the natural teeth still in the mouth.

But if the roots cannot be filled, the denture that is made to fit over them, must be considered only temporary. The roots decay, particles break off, the gums become inflamed over the carious border of the root, and are then irritated by the pressure of the plate. The latter is raised from the gums by the swelling of gum over these rough edges, and hence the anterior portion of the plate not being

in firm contact with the gums is loose, resulting in a space between the gums and the artificial crowns of the plate.

These firm roots are filled, and a plate introduced over them, and in these cases the swelling and inflammation of the gum is not to be feared so much, though it may not be entirely absent even in these cases; hence generally only those dentures are the most satisfactory that are introduced on the perfectly shrunken arch and entirely healed gums that usually follow the removal of teeth and roots.

In this case the suction of the plate is more perfect than when the cushion of gum is not continuous, but interrupted by firm roots.

If after the extraction of a number of roots, entire shrinkage of the gums cannot be awaited, a temporary set must be made, which is replaced by a permanent one in from six to nine months. The temporary plate may be introduced according to the size and number of teeth extracted within a few days or weeks after extraction.

If it is certain that the patient will permit the extraction of all roots that must be removed at one sitting, the denture may be prepared beforehand. In that case the model of plaster-of-paris is cut out in those positions corresponding with the roots to be extracted, and into these conical cuts or holes the artificial teeth are fitted. When the plate is put in the mouth, these artificial teeth reach into the gums, and the latter surround the artificial crowns. Such a temporary plate can be worn for a longer time than one that is made after the necessary shrinkage of the gums, and in which the artificial crowns are fitted on the natural gum. It is necessary that an artificial denture whose teeth reach into the alveoli in this manner should be worn day and night, as otherwise the alveoli become flattened and smaller, causing the artificial teeth to press upon them.

The Impression.

When the mouth is entirely prepared for the reception of artificial teeth, an impression of the alveolar processes and gums is secured, and during the making of the plate the presence of the patient is not required. An impression cup and impression material is necessary. The impression cup must approximately correspond with the shape of the gums and alveolar processes; hence there are various widths and sizes to fit the various heights of the palate.

The impression material must be introduced into the mouth in a very soft condition, and must be removed from it in as hard condition as possible. Formerly wax was generally used for this purpose, and then gutta-percha. But wax, if introduced in a fairly soft condition, does not harden rapidly, and hence does not prevent the drawing or injury of the impression in removal. Gutta-percha requires much heat to become sufficiently plastic, and its contraction on cooling is considerable. Lately a mixture composed of isinglass, madder, stearic acid, oleic acid, and copal (Stent's composition) is much used. This becomes very soft in a warmth readily borne by the mucous membrane, and is sufficiently hard within one and a half to two minutes, not to become displaced while removing it from the mouth.

Plaster-of-paris is also extensively used as an impression-material. But in a soft condition it does not cohere as Stent's composition, hence it may readily happen that some of the mixture of plaster-of-paris that passes out at the borders of the impression cup, may fall on the tongue. Otherwise plaster-of-paris possesses all the properties that can be desired of an impression-material, and in a most satisfactory manner. The plaster must not be permitted to become too hard while in the mouth, otherwise it may be difficult to remove it. Frequently it is necessary to refasten small pieces of plaster that are broken off in removing the impression.

The Model and Cast.

From the impression a model of plaster-of-paris representing the jaw is produced. In the impression the jaw is represented negatively; the model secured by pouring plaster into the impression, will represent the jaw positively. The separation of the hardened plaster-of-paris from the impression is easily accomplished by softening the impression material in warm water, but plaster impressions must be removed from the plaster model with care. On the model thus obtained a denture with a rubber base can be made. If the plate is to be made of gold or platinum, the preparation of a positive and negative metal die is necessary, and between these the plate is stamped or struck up. Generally for the making of the positive die zinc is employed, for the negative lead; recently both are made of Spence metal. But this can be used only when the plate is to be pressed, because the strokes of the hammer will fracture the metal.

To obtain the zinc model, the plaster model is negatively reproduced in molding sand, into which the liquid metal is poured. The negative lead die is produced by pouring lead on the zinc.

The Spence metal can be poured directly into the impression. The model thus produced is placed in an iron pan and the space between it and the walls of the pan filled with plaster-of-paris. After the latter is hardened an iron ring is placed around it and into this the Spence metal is poured, being then closed with a cover. Thus a counter-die is produced; between the two the gold plate is pressed.

For vulcanite plates, a plate is first made of wax, and on this the artificial teeth to be used are temporarily fastened; in the case of metal dentures the teeth are fastened to the metal plate.

The length of the teeth is arranged according to the length of those in the opposing jaw. In closing the mouth all the lower molars must meet the upper ones. This cannot be done if the natural molars in the opposing jaw are missing, and hence the position of the lower jaw against the upper must be fixed at a certain distance. This is done by fastening to the plate of wax or metal, as the case may be, a strip of wax, approximately the length of the artificial teeth; the same is done with the lower jaw. The mouth is then closed, and when the lower and upper strips of wax come in contact evenly, both are fastened together with a heated spatula in several places. The plates are then again replaced on the models, without dividing the strips of wax; the former will retain their relative positions as they will be when the dentures are prepared, and placed in the jaw and articulated. It is now only necessary to fix the models to each other in this normal position in such a way that they can be readily replaced after the removal of the wax. This is done by pouring plaster-of-paris against the posterior ends of one of the models, and into this cuts or projections are made, which will correspond with depressions and projections of the plaster poured upon the other model. For this purpose there are also more or less complicated articulators in the market, to which the models can be attached with plaster.

Artificial Teeth.

The artificial teeth now in use are made of strong porcelain. They consist of silax, feldspar and kaolin. The necessary tones of

color are produced by the addition of various earths and metallic oxides. For the purpose of attaching them to the plate, platinum pins are baked into them, and for cases of young persons, in whom the alveolar border is considerably absorbed, the artificial teeth are provided with porcelain representing the color of the gum. This produces the most perfect representation of the gum. The dentist himself can manufacture the porcelain gum, while he always purchases the teeth of the dealer. Generally it will be found more convenient to represent the gums by a border of pink rubber. In the case of old persons the border should be narrow, and the teeth long, because in natural cases when the teeth are present, they are long. Short teeth and thick borders of gum, being unnatural, are readily detected.

Retention of Artificial Teeth in the Mouth.

Incisors or cuspids can be replaced by artificial crowns to which a pin is attached; they are fastened into the roots; for these cases the roots must of course be present and in a firm condition. Such pivot-teeth seldom cause inconvenience.

When the roots are missing, or where a larger number of teeth are inserted, they are attached to a plate that covers the alveolar process, and in the upper jaw the palate also. To these plates clasps are sometimes attached, which are clasped about firm natural teeth in the mouth, and thus assist in the firm retention of the plate.

In those cases in which the patients do not observe perfect cleanliness, the plate as well as the clasps will become a source of the destruction of the natural teeth with which they come in contact. This results from the retention of thickened mucus and remnants of food between the plate and the tooth. These materials ferment in these positions, creating lactic acid, which attacks the natural teeth. In this manner, the natural teeth of persons that wear artificial teeth are attacked by caries on the lingual side, in a position in which decay occurs otherwise but very seldom. The clasps surround the teeth in question always at least one-half, frequently three-fourths of their circumference, while the plate surrounds the separate teeth about one-fourth or one-third. Hence the destructive results are observed more frequently on the teeth surrounded by clasps, and their use has been therefore almost wholly discarded. Some have

endeavored to obtain satisfactory results by using broad plates, which act as suction-plates, covering a larger surface of the gums. Careful observation shows that in partial plates suction is not always sufficient. For the purpose of securing perfect suction, it is necessary that the borders of the plate especially should lie firmly against the gums. But about the natural teeth that are still in the mouth, this is, as a rule, not entirely possible, since alongside of these the air finds entrance and occasions a loosening of the plate. Clasps are still resorted to in these cases; and in the lower jaw, where the surface to be covered by the plate is but slight, the use of clasps in partial cases is almost universal. Plates or the clasps are uninjurious, if the artificial teeth, as well as the natural ones, are cleaned thoroughly and carefully at least three times a day. Partial plates should not be worn during the night. Exceptions to this rule are those cases in which the artificial teeth are introduced into the newly made alveoli of extracted teeth. The object of retaining the plate day and night in the mouth is in order to prevent contraction and the formation of granulations in the alveoli. These plates should be worn until entire absorbtion has taken place, which occurs in about six months; but in order to be thus worn they must be well attached and kept very clean.

When all the teeth are absent in one or both jaws, a plate held in position by suction offers the greatest satisfaction. Clasps cannot be used in these cases. But if suction is not sufficient to retain the dentures in position the use of spiral springs may be resorted to. These are attached at the side of the denture in such manner that they form a posteriorly convex curve, and by their disposition to remain perpendicular they press the upper plate against the upper jaw and the lower plate against the lower.

The attachment of the dentures frequently becomes unsatisfactory in course of time, for various reasons. If roots are permitted to run under the plate, these become raised in their sockets as a result of chronic inflammation of the periosteum. In other cases they become decayed on their exposed surfaces, the gum grows over them, and this is sufficient reason why the plate does not fit as well as formerly; it does not rest on the basis to which it was fitted but on the diseased projections. If the roots have been extracted, the alveolar process is rapidly absorbed, and the temporary set soon becomes loose. And now a new denture is necessary, and this in

turn also becomes loosened through further shrinkage. Sometimes the shrinkage and absorbtion after extraction continues for a whole year. The consequences are still more disagreeable if no temporary set has been worn. The patient becomes restless and impatient, and cannot await the time until entire shrinkage has taken place; and that the dentures were introduced too soon becomes apparent when the adaptation becomes unsatisfactory.

By the negligence of patients a tooth that has been surrounded by a clasp occasionally decays and is broken off; the clasp has lost its service and the plate is loose. At other times the clasp may break off, or even the entire plate may break, and the patient delays having the damage corrected.

Some persons become so accustomed to wearing their artificial teeth that they cannot fall asleep unless they wear them; others wear the teeth during the night, following the recommendation of their dentist, because it has been observed that plates which are not worn during the night appear looser in the morning and because the ill consequences of wearing artificial teeth during the night have not been sufficiently explained. So long as a full set of teeth has sufficient adaptation, it may be worn during the night, but if the adaptation is not sufficiently firm, it is dangerous. In the literature of the profession I have found on record over sixty cases in which dentures had been swallowed, and of these cases several resulted in death. In most cases the dentures are not firmly adapted, and their passage into the œsophagus occurred during the night.*

Dentures on Vulcanized Rubber Bases.

These are most commonly used now. The vulcanized rubber for this purpose is placed on the market in sheets of the thickness of from 1 to 1.5 mm. It is mixed with sulphur and red oxide of mercury, the latter imparting the color; in working it, the rubber is plastic and fresh, sometimes almost mushy. By subjecting it to a temperature of 160° C. (320° F.) for the period of an hour it becomes as hard as horn, and has then sufficient durability neither to become worn to any extent by use in the mouth, nor to become destroyed by mechanical influences.

The process of making artificial teeth with this base is briefly as follows: After the impression has been taken and a cast made,

*See Parreidt, *Handbuch der Zahnersatzkunde*, Leipzig, 1880.

teeth of the proper color and form having been previously selected, are ground with corundum stones to fit the gums snugly, and of the proper length. They are then properly arranged and fastened to a wax plate that has been softened and pressed to fit the cast. The plate and teeth are tried in the mouth, and changes, if any are necessary, made. The teeth are then imbedded in plaster, allowing it to cover their anterior and proximal surfaces, so that after the removal of the wax they retain their position. In place of the wax the vulcanized rubber is packed, the platinum pins of the teeth, which are roughened or bent, unless they are provided with heads, become attached in the rubber. The flask is closed, placed in the vulcanizer, and heated to a temperature of 160° C. (320° F.), and maintained at this temperature for an hour. After cooling, the dentures are removed and the hard rubber is filed, scraped, and finally polished. In fitting the teeth to the mouth it is sometimes necessary to grind away a small amount from their masticating surfaces in order that they may articulate properly. That the borders of the plate should not be too sharp, is evident, and also that care should be observed not to permit undue pressure on the soft parts, the fræum of the lips and tongue and the attachment of the muscles; otherwise the plate would either become loose in speaking, or the soft parts will ulcerate. Neither should the teeth project too far forward, for then they are readily loosened. The molars must stand perpendicularly on the alveolar border. Pressure on the molars of one side should not loosen the plate on the other side.

About ten years ago celluloid was used very much as a base for artificial teeth. Its advantages were found in beautiful color and slight transparency, as did its hardness. Time, however, proved that the material was subject to decomposition when worn in the mouth; hence its use has been almost wholly abandoned.

Dentures on Metal Bases.

Gold is preferable by being made in thinner plates, and having the same or even greater strength than rubber. The gold plate need be only from 0.3 to 0.4 mm. in thickness, while the rubber plate must be from 1 to 2 mm. thick. Hence a gold plate is indicated in all those cases in which there is not room for a thicker plate, and this is the case when the lower incisors, in articulating, either entirely or almost wholly touch the gums behind the upper incisors.

For artificial dentures the gold used is not chemically pure, as for fillings, because it would be too soft: but the plates are made of alloys of gold, silver, and copper. The quantity of copper should not be great. The alloy used for jewelry in Germany is about 14 karat. For use in the mouth such a low karat is not serviceable because it is readily oxidized; the alloys used, therefore, are from 18 to 20 karat, with about one-tenth copper; the remainder is gold and silver. The shape of the plate is obtained by pressure, or by striking it up between two metal dies, one positive and the other negative.

The artificial teeth are attached to the plate by soldering with 16 or 18 karat solder.

Instead of gold, platinum may be used, and this is essential if the denture is to be made with porcelain facings. In these cases the platinum plate is soldered to the teeth with pure gold, and the porcelain mass formed on the plate and about the teeth in a semi-plastic form; this is afterwards baked.

As plates struck up between metal dies require much time and skill, and still the plate is frequently not so perfectly adapted to the gums as a plastic material (vulcanite), which is molded on the plaster cast, dentures of metal have been made by pouring the latter into a plastic form. For this purpose aluminium has been used (Sauer, Bean), and also alloys of silver, tin, bismuth, and some antimony. But these methods have not been accepted with much favor. Aluminium does not give satisfaction in the mouths of most people.

Obturators and Artificial Palates.

That in marked absorption of the alveolar processes, dentures must also replace the loss of the jaw and gums has been previously mentioned. For this purpose either vulcanite is employed, or so-called gum-teeth. The vulcanite can be used much more readily, but has not so good an appearance. It is of greater service in replacing lost portions of the jaw, which may be wanting either as a result of injuries or operations. After healing of the parts a denture is made, and the portions to be replaced are filled with gutta-percha in order that the soft parts and bony processes may make impressions therein, and finally the gutta-percha is replaced by vulcanite. Sometimes the introduction of pieces that are designed to replace portions of the jaw, are accompanied with many difficulties, from the shrink-

age of the cicatrix in either the lips and the cheeks, or of the muscles of the lower jaw, which usually occurs after operations about these parts. It is not the province of this work at this time to consider these difficulties.

Obturators are essential in congenital or acquired clefts of the palate. At present, in Germany, the obturator most generally used for the correction of congenital cleft palate is Süersen's obturator; this apparatus has been received with much favor in other countries also; its modification by Schiltsky is also used.

Süersen's obturator is made in the following manner: A plate is made for the hard palate as for artificial teeth, and is attached in a similar manner, generally by the use of clasps. At the posterior edge the plate extends in a tongue-shaped projection, which extends into the cleft in the soft palate and to within one-half of the posterior wall of the pharynx. After the patient has worn the plate for several days and become perfectly accustomed to it, its extension is roughened and covered by a piece of softened gutta-percha, the size of a walnut or even larger. The apparatus is immediately replaced, in order that the soft parts of the throat, the folds of the mucous membrane, and the posterior constrictor of the pharynx may leave their impressions in the gutta-percha while they are in motion during swallowing and speaking. The patient is requested to read, if possible, or he should be engaged in conversation, that the soft parts of the pharynx may have an opportunity to assume all their various positions, and to impress them in the soft gutta-percha. In a quarter of an hour the apparatus is removed from the mouth, and the superfluous gutta-percha is cut away, or in case there is not sufficient of it, some may be added. Generally, it is necessary to cut away at the lower surface, as the muscles contract with considerable force when first in contact with the gutta-percha, and hence press the material downward. Therefore it is necessary to add more gutta-

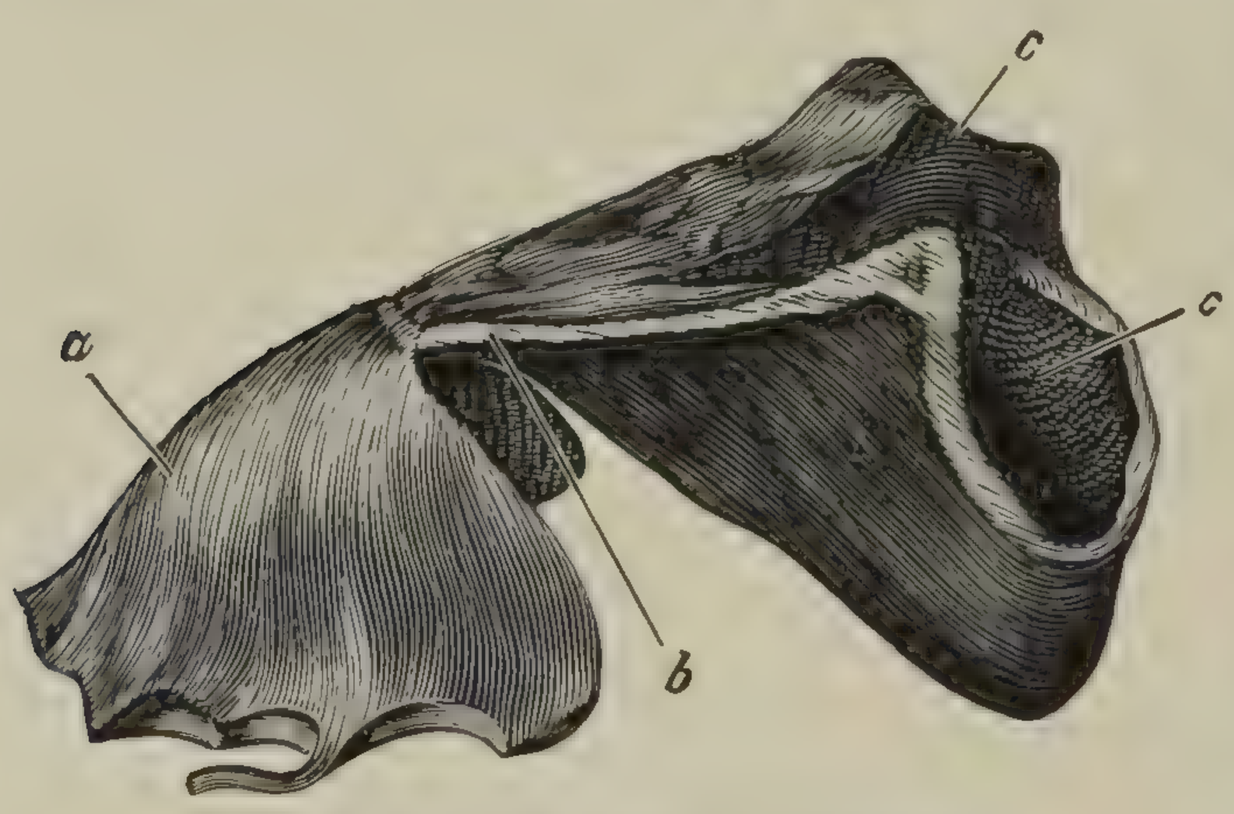


FIG. 38.—*Süersen's Obturator.*

percha, at the sides, above and posteriorly; then the apparatus is again replaced to be followed by the exercises of reading and speaking, after which the impressions in the gutta-percha are carefully examined.

In the material should be represented an impression of the constrictor of the pharynx, the impressions of the folds of the mucous membrane, and of the tuberosities (See Fig. 38). If these impressions have been thus secured the patient may wear the apparatus for one or more days, so that the impressions become still more marked. It is advisable to again add gutta-percha, and to observe whether it becomes displaced or whether it remains in position and is necessary.

If the apparatus is properly constructed, the patient must pronounce the letters m and n distinctly, and not with a sound of p or b. If this is not the case, and the patient speaks as if affected with a cold or with hypertrophy of the tonsils, the apparatus is too large, when the mouth is closed not sufficient air can enter between the obturator and the wall of the pharynx or between the obturator and the nasal passages. Some of the gutta-percha should therefore be removed from these positions. If the impression is correct, its shape is secured by plaster impressions and then the gutta-percha is removed to be replaced by the vulcanized rubber which is polished after having been hardened.

After introducing the apparatus, immediate material improvement in speech should not be expected. The patient must learn to speak; formerly he could not acquire a correct pronunciation, because an essential condition was wanting, namely, the ability to open or close the connection between the oral and nasal cavity according to pleasure. Therefore the patient has acquired peculiar movements of the tongue and lips that are advantageous during the presence of the defect, but are entirely useless after the introduction of the apparatus. With the obturator the patient is able to open and close the connection between the oral and nasal cavity. This is done by the contraction or expansion of the posterior constrictor of the pharynx. But this muscle must learn and become more accustomed to this function. It must be gradually developed and become stronger, before the pronunciation can be entirely distinct; in addition to this the unnatural and now useless movements of the tongue must be replaced by natural and useful ones. Some persons,

especially the most intelligent, learn pronunciation in from one to two months, others in years, and some never.

At what age an obturator should be resorted to, is readily decided when we remember that it is of the greatest advantage for the individual that normal pronunciation be secured as soon as possible. It is of great advantage that a child should receive the apparatus before entering school; on the other hand some children lack the patience and intelligence that are necessary at this age to become accustomed to the apparatus. It must be remembered also that during childhood and youth, while the teeth are being shed and erupted, and the jaws are growing, new obturators must be made frequently.

Schiltsky's modification of Süersen's apparatus consists in the fact that in place of that portion of the obturator extending into the nasal cavity, and which is made of hard vulcanite, he recommends one made of semi-elastic rubber. It is connected with the hard vulcanite covering the hard palate either by a gold spiral spring, or is directly vulcanized to it. Schiltsky's apparatus is certainly preferable, because the folds of the mucous membrane can compress the soft walls of this portion of the piece, whereby the posterior wall is expanded. Hence this wall is pressed against the constrictor of the pharynx, which is contracting at this time, and the connection between the oral and nasal cavity is cut off more readily and more perfectly than with an apparatus whose walls are inflexible.

Another advantage of the flexible walls is found in those cases in which a portion of the soft palate is not entirely separated, or in which it was united by an operation; this intact portion by its movements does not displace the entire piece, as is invariably the case with Süersen's apparatus, but the soft walls attached by the spiral spring move independently of the hard portion of the plate, without dislodging the latter.

On this advantage Jul. Wolff lays special stress. In his opinion staphylorraphy or a uranoplastic operation should be performed in every case. If after proper lessons in speaking, which are given, as Süersen recommended, in the best manner by teachers of the deaf and dumb, speech does not become normal, Schiltsky's obturator may be resorted to, without separating the soft palate as is necessary when Süersen's obturator is used.

The disadvantages of Schiltsky's apparatus are found in the

destruction of the semi-elastic rubber taking place in the mouth in a few years, and the opening into which the air is blown becoming readily destroyed, so that the walls become limp, and do not lie in proper contact with the soft parts.

The preparation of an obturator with semi-elastic walls is more delicate than that of a hollow or massive obturator made of hard rubber.

In addition to these two obturators mentioned, Dr. Kingsley's may be referred to. That portion that corresponds with the soft palate consists of a single or double layer of semi-elastic rubber, which rises and falls with the movements of the soft palate. The obturator is still much employed in the United States and in England, though Kingsley has expressed himself in favor of Süersen's apparatus.

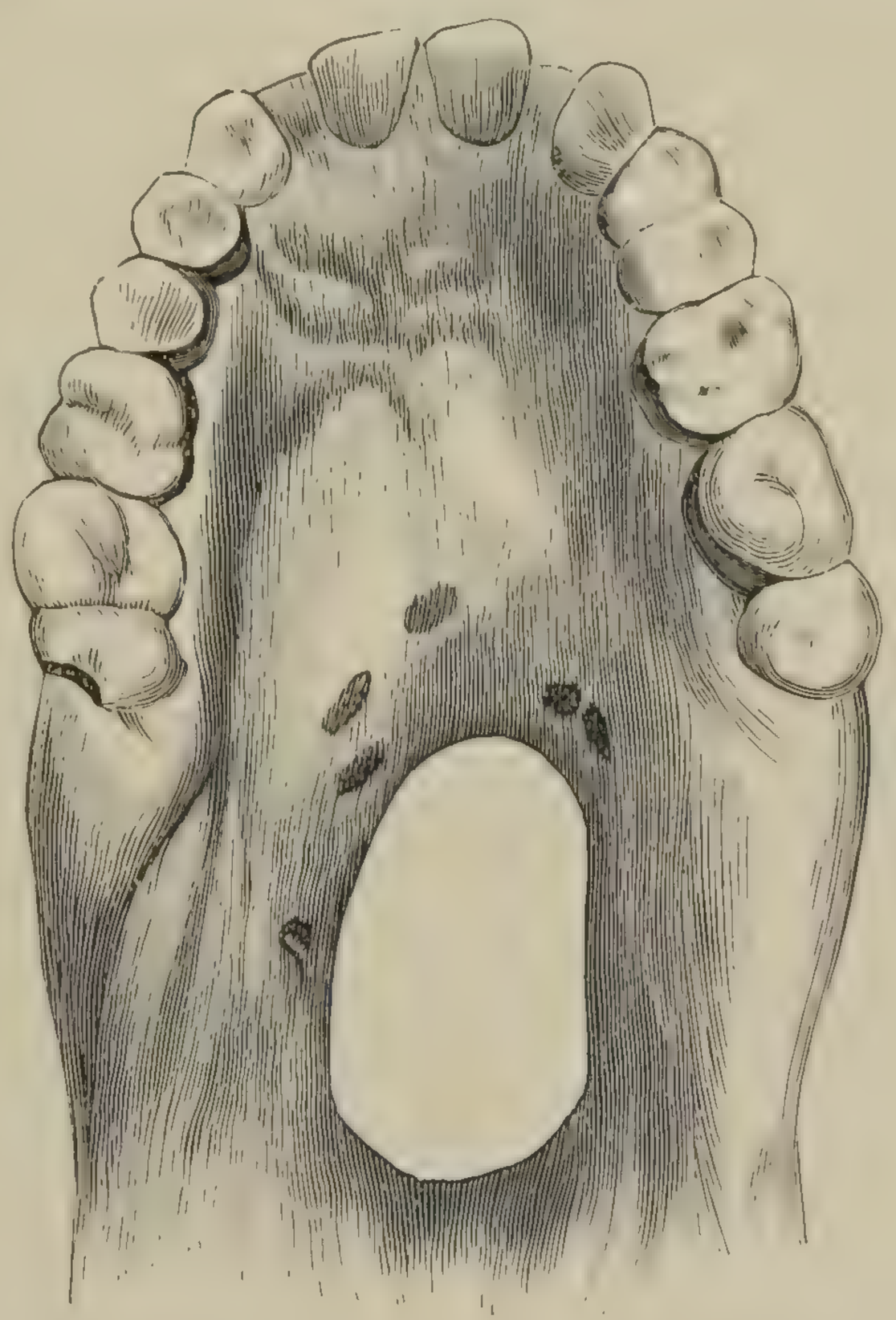


FIG. 39.—*Cicatricial union of the soft palate with the pharynx.*

The irregular defects resulting in consequence of syphilis or lupus, require a prothetic method of treatment similar to that of congenital defects of the palate. Openings in the hard palate may be closed with a simple plate. Openings at the border of the hard with the soft palate may be similarly closed by an extended hard rubber plate. The simple covering, however, is not sufficient; at the point corresponding with the defect the plates should be thicker, and extend into it like a cork, that it may be in contact with the soft palate during all of its motions.

The expression in acquired defects becomes distinct immediately after the introduction of an obturator. The patients are not required

to discontinue the unnatural movements of the tongue, as they were able to articulate properly before the appearance of the defect.

There are some cases that are not followed by perfectly satisfactory results. It sometimes happens that in consequence of syphilitic ulceration, the soft palate becomes united with the wall of the pharynx, thus leaving a larger or smaller irregularly shaped opening in the cicatrized structure between the opening of the mouth and nose (Fig. 39). If this opening should be entirely closed the patient could not breathe through the nose or speak distinctly. If an opening is allowed to remain, the speech remains nasal. It must be ascertained how far back the plate may extend in order to make speech the least nasal, and to allow sufficient communication of air between the oral and nasal cavities.

TABLE FOR THE CONVERSION OF DEGREES ON THE CENTIGRADE THERMOMETER INTO DEGREES OF FAHRENHEIT'S SCALE.

CENT.	FAHR.	CENT.	FAHR.	CENT.	FAHR.
— 50	— 58.0	18	64.4	62	143.6
— 45	— 49.0	19	66.2	63	145.4
— 40	— 40.0	20	68.0	64	147.2
— 35	— 31.0	21	69.8	65	149.0
— 30	— 22.0	22	71.6	66	150.8
— 25	— 13.0	23	73.4	67	152.6
— 20	— 4.0	24	75.2	68	154.4
— 19	— 2.2	25	77.0	69	156.2
— 18	— 0.4	26	78.8	70	158.0
— 17	+ 1.4	27	80.6	71	159.8
— 16	3.2	28	82.4	72	161.6
— 15	5.0	29	84.2	73	163.4
— 14	6.8	30	86.0	74	165.2
— 13	8.6	31	87.8	75	167.0
— 12	10.4	32	89.6	76	168.8
— 11	12.2	33	91.4	77	170.6
— 10	14.0	34	93.2	78	172.4
— 9	15.8	35	95.0	79	174.2
— 8	17.6	36	96.8	80	176.0
— 7	19.4	37	98.6	81	177.8
— 6	21.2	38	100.4	82	179.6
— 5	23.0	39	102.2	83	181.4
— 4	24.8	40	104.0	84	183.2
— 3	26.6	41	105.8	85	185.0
— 2	28.4	42	107.6	86	186.8
— 1	30.2	43	109.4	87	188.6
0	32.0	44	111.2	88	190.4
+ 1	33.8	45	113.0	89	192.2
2	35.6	46	114.8	90	194.0
3	37.4	47	116.6	91	195.8
4	39.2	48	118.4	92	197.6
5	41.0	49	120.2	93	199.4
6	42.8	50	122.0	94	201.2
7	44.6	51	123.8	95	203.0
8	46.4	52	125.6	96	204.8
9	48.2	53	127.4	97	206.6
10	50.0	54	129.2	98	208.4
11	51.8	55	131.0	99	210.2
12	53.6	56	132.8	100	212.0
13	55.4	57	134.6	148.9	300.0
14	57.2	58	136.4	176.7	350.0
15	59.0	59	138.2	204.4	400.0
16	60.8	60	140.0	232.2	450.0
17	62.6	61	141.8	260.0	500.0

The equivalents of English weights and measures of those metrical weights and measures which are used in chemistry can be readily found by the aid of the following table, which is available not only for grammes, centimetres and litres, but, by mere change of the position of the decimal point, for all decimal multiples or subdivisions of these quantities.

TABLE FOR THE CONVERSION OF GRAMMES INTO GRAINS, CENTIMETRES INTO INCHES, AND LITRES INTO QUARTS.

	1	2	3	4	5	6	7	8	9
Grammes into grains..	15.4323	30.8647	46.2970	61.7294	77.1617	92.5941	108.0265	123.4588	138.8911
Centimetres into inches	.3937079	.7874158	1.1811237	1.5748316	1.9685395	2.3622474	2.7559553	3.1496632	3.5433711
Litres into Imp. quarts.	.088066	1.76132	2.64198	3.52264	4.40330	5.28396	6.16462	7.04528	7.92594
Litres into U.S. quarts.	1.05708	2.11415	3.17123	4.22830	5 28838	6.34245	7.39953	8.45660	9.51368

Table for the Conversion of Weights and Measures.

One pound avoirdupois	=	7000	grains	=	453.59 grm.
" " troy	=	5760	"	=	373.24 "
" ounce avoirdupois	=	437.5	"	=	28.35 "
" " troy	=	480	"	=	31.10 "
" grain	=			=	64.80 mgrm.
" U. S. standard gallon	=	231	cu. in.	=	3.78 litres.
" English imperial gallon	=	277.274	" "	=	4.54 "
" foot	=			=	0.3048 metre.
" yard	=			=	0.9144 mgrm.

One cubic metre	=	35.31660	cubic feet.
" " decimetre (a litre)	=	61.02709	" inches.
" " centimetre	=	0.06103	" "
" litre	=	0.22017	Imp. gallon.
" "	=	0.88066	" quart.
" "	=	1.76133	" pint.
" "	=	0.26427	U. S. gallon.
" "	=	1.05708	" quart.
" "	=	2.11415	" pint.

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NOW READY.

A STUDY

OF THE

Histological Characters

OF THE

Periosteum and Peridental Membrane.

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—*Dr. C. N. Pierce in* AM. SYSTEM OF DENTISTRY.

CHICAGO:

W. T. KEENER, PUBLISHER,

96 Washington Street.

ESTABLISHED NOVEMBER, 1886.

THE DENTAL REVIEW,

DEVOTED TO THE ADVANCEMENT OF DENTAL SCIENCE.

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LOUIS OTTOFY, D.D.S.
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PUBLISHED MONTHLY.

SUBSCRIPTION PRICE, $2.50 PER ANNUM.

Foreign Subscription, $3.00.

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